The Plant Kingdom

Division: Bryophyta (mosses)

Characteristics

- Growth of protonema only apical; most of protonema with oblique walls
- Differentiated oil bodies lacking
- Rhizoids multicellular
- Leaves usually not lobed, spiral
- Many plastids per cell

Characteristics (cont.)

- Only leafy growth forms
- Protonema from one spore producing more than one gametophore
- Sex organs free and emergent
- Sporophyte in most emerging early from the calyptra; sporogenesis simultaneous

Characteristics (cont.)

- **Seta present and elongating during ontogeny**
- **Elaters absent**
- **Most with operculum and peristome (except Sphagnidae and Andreaeidae)**

Moss Growth Forms

- **Acrocarpous mosses**
  - archegonia terminate the main shoot
  - sporophyte is terminal
  - primarily “erect” mosses

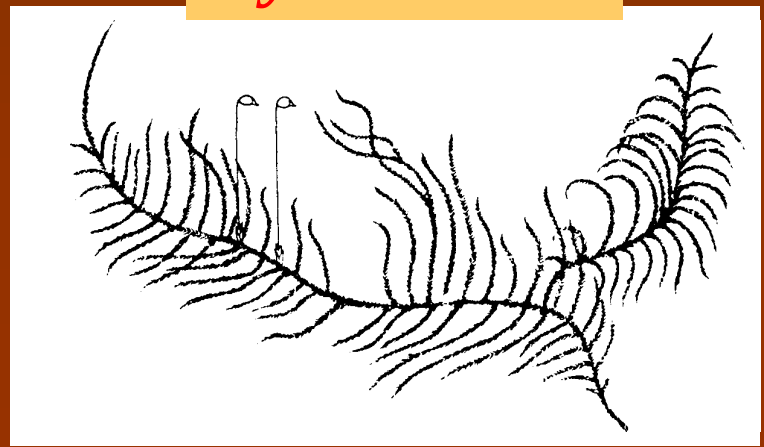
Dicranum

Polytrichum

Moss Growth Forms (cont.)

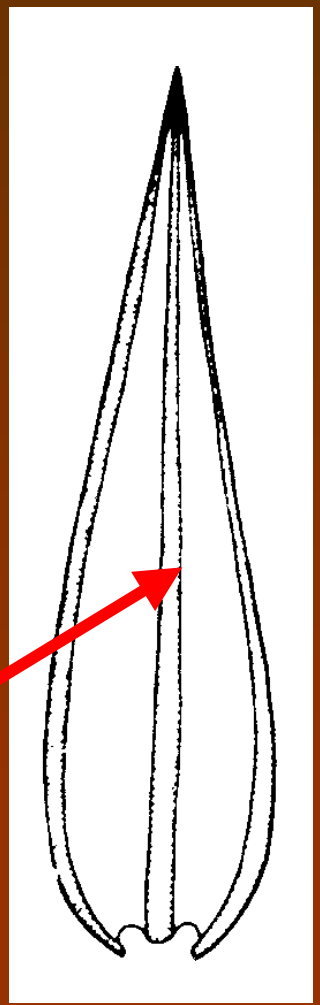
- **Pleurocarpous Mosses**
  - archegonia are on short lateral branches
  - apical cell is not used up
  - sporophytes shorted, bud-like
  - “creeping” mosses

Hylocomium

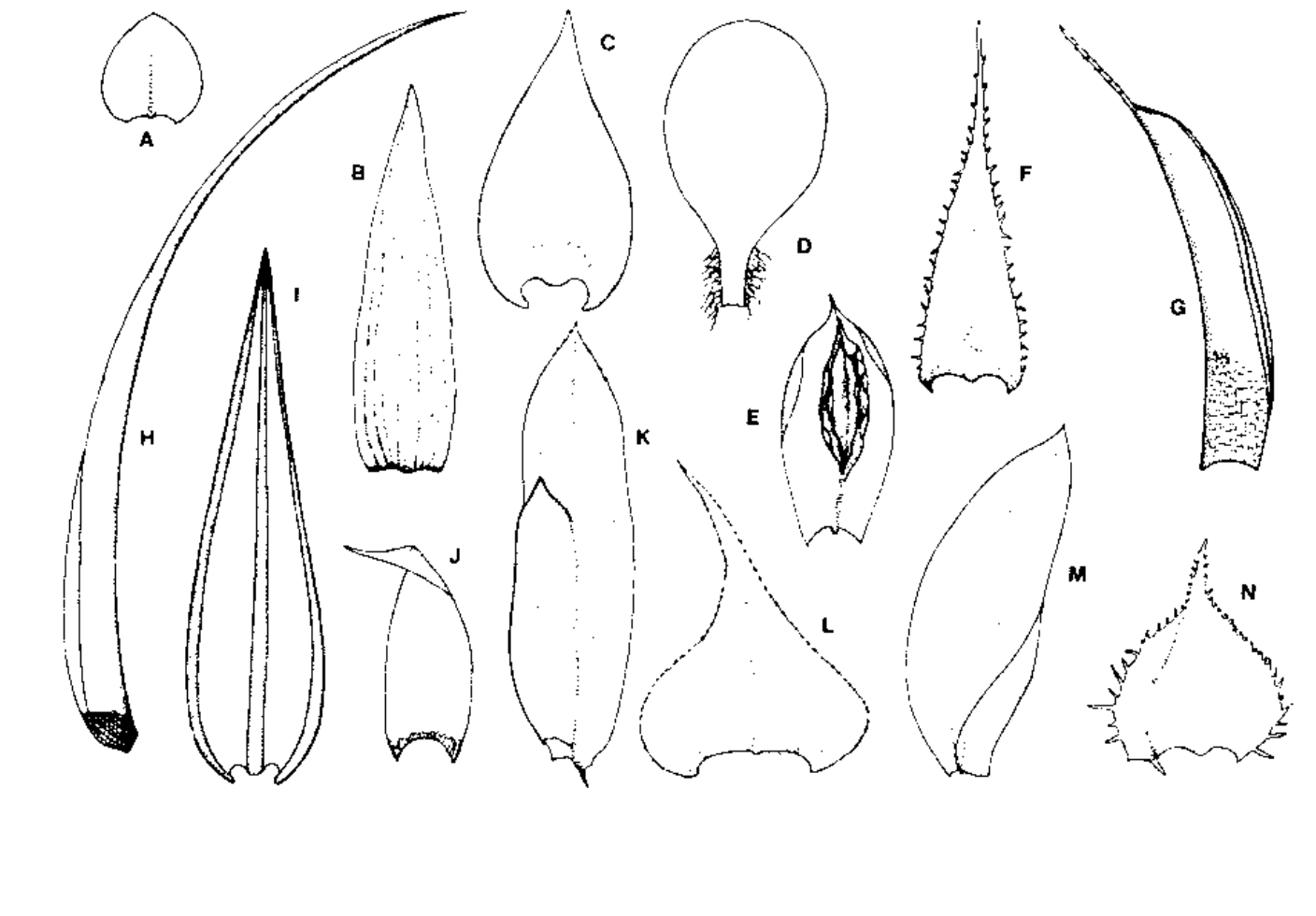


Vegetative Features
(gametophyte)

"Leaves" of mosses frequently have a midrib or costa



Leaf Diversity in Mosses



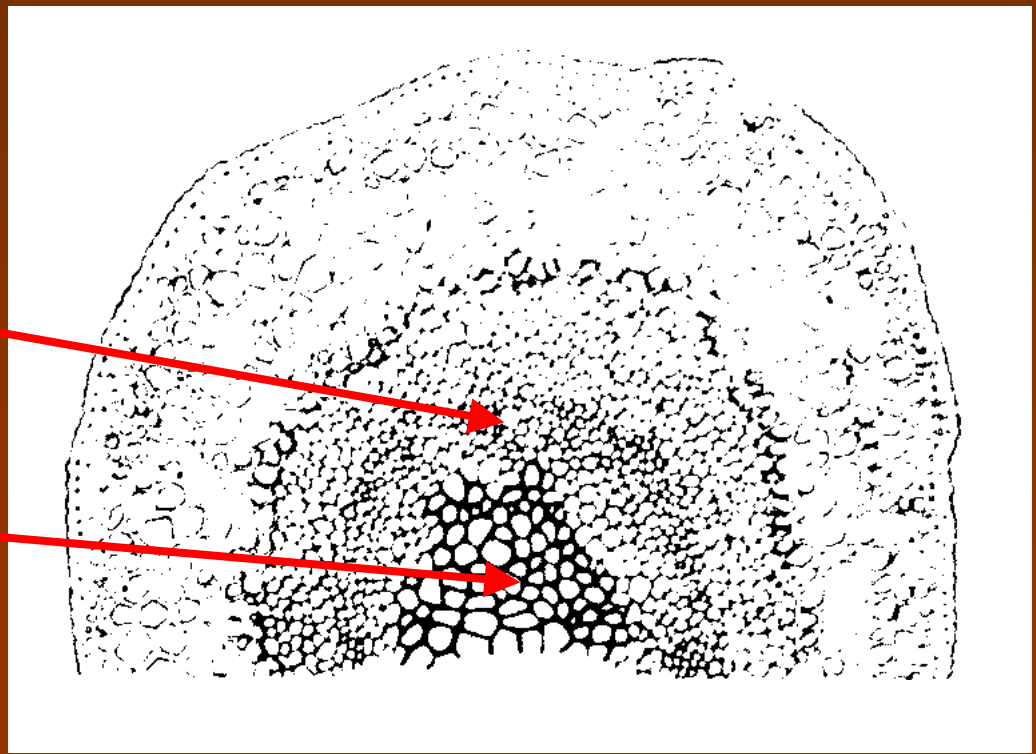
Vegetative Features
"stem" of the gametophore

- Outer cortical cells (epidermis)
- central strand present in many
  - the central strand may have specialized water-conducting cells known as HYDROIDS and food-conducting cells called LEPTOIDS
  - these cells are common in members of the Subclass Polytrichidae

Central Strand of *Polytrichum*

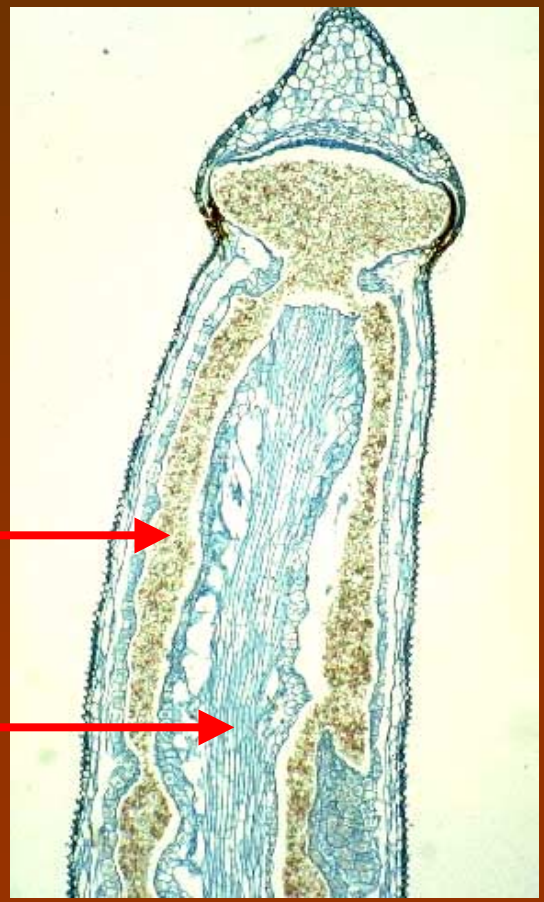
LEPTOIDS

HYDROIDS



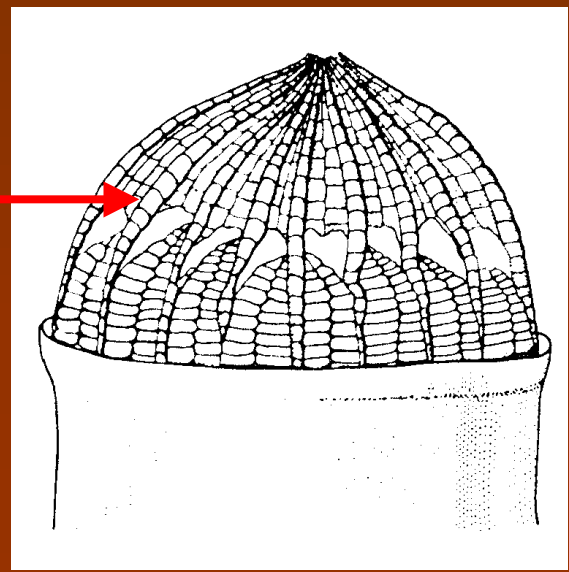
Anatomy of the Moss Sporophyte

- The sporophyte capsule is elevated on a long seta
- Capsules contain sporogenous cells which undergo meiosis to form haploid spores
- Center of the capsule is often a stalk-like columella



Anatomy of the Moss Sporophyte

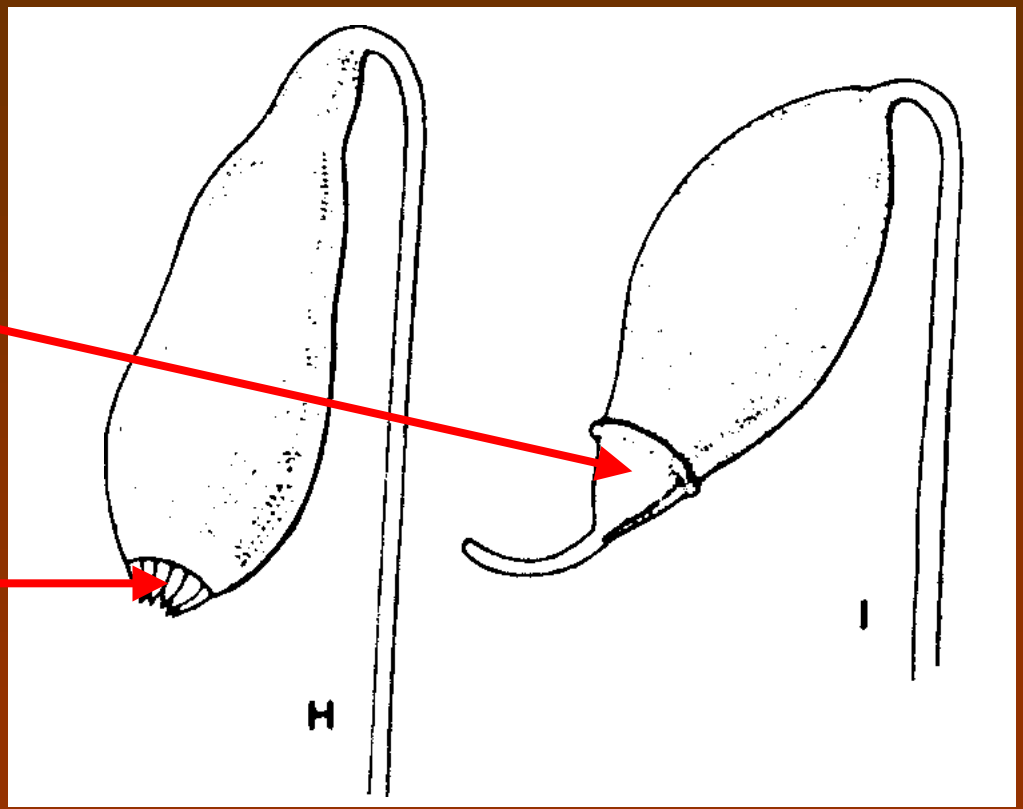
- Base of the capsule may become swollen (apophysis)
- Capsules usually have a “lid” or operculum covered by the calyptra
- Under the operculum is typically a peristome composed of hygroscopic peristome teeth involved in spore dispersal



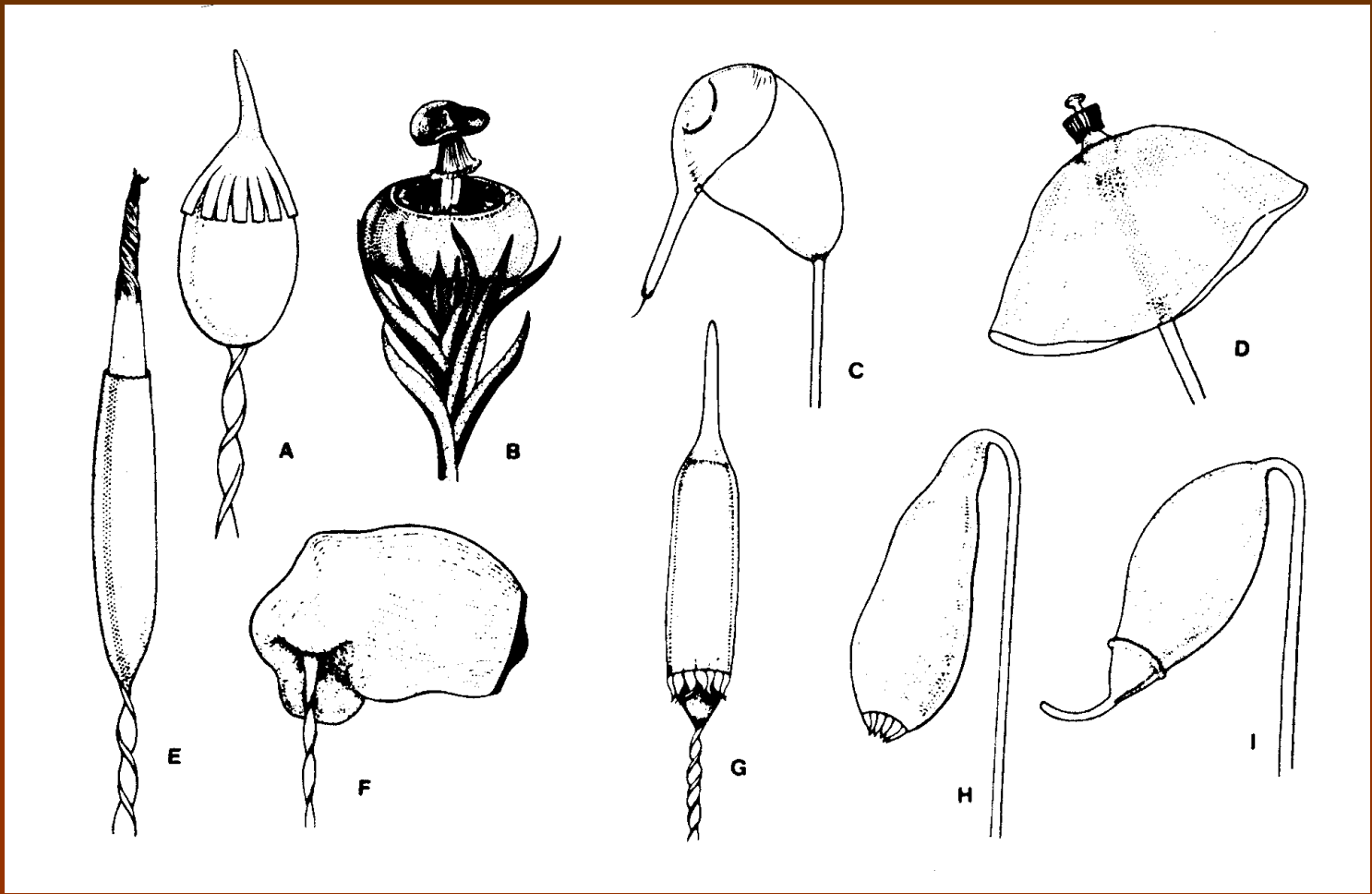
Moss Capsules

operculum

peristome



Moss Capsule Diversity



Generalized Moss Life Cycle

- Moss spores germinate forming a filamentous protonema stage
- Protonema gives rise to many leafy gametophores with multicellular rhizoids
- Gametophores are usually separate male and female plants (dioicous)

Generalized Moss Life Cycle (cont.)

Protonema Stage

Moss Protonema

Generalized Moss Life Cycle (cont.)

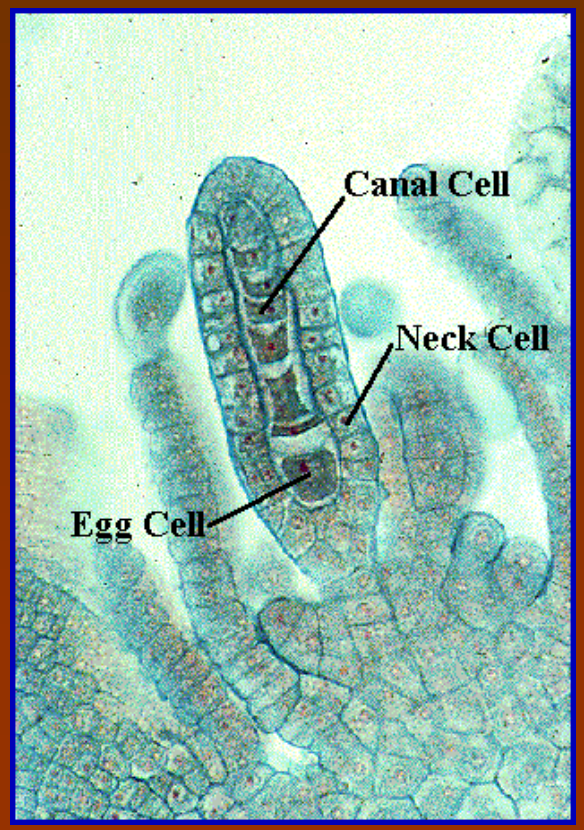
- On male plants, multicellular antheridia are produced surrounded by special perigonial leaves
- The antheridia produce flagellated sperm which are usually "splashed" from the male moss onto the female moss plant

Antheridia in *Mnium*

Generalized Moss Life Cycle (cont.)

- Female plants produce archegonia
- Archegonia have a neck (with neck cells and canal cells) and a venter (with the egg cell)
- The archegonia surrounded by perichaetial leaves
- Neck canal cells disintegrate allowing sperm to fertilize the egg

Archegonia in *Mnium*



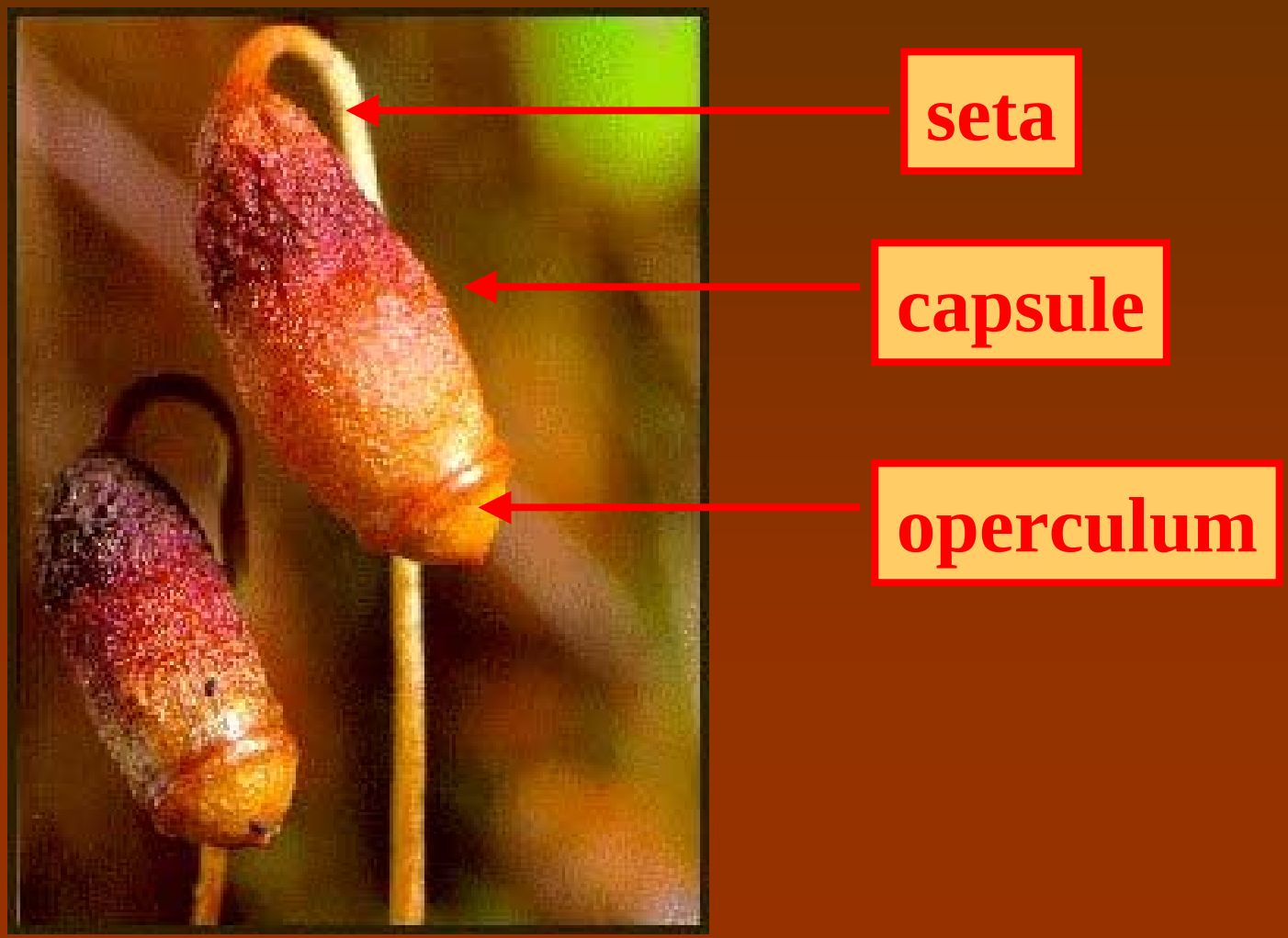
Generalized Moss Life Cycle (cont.)

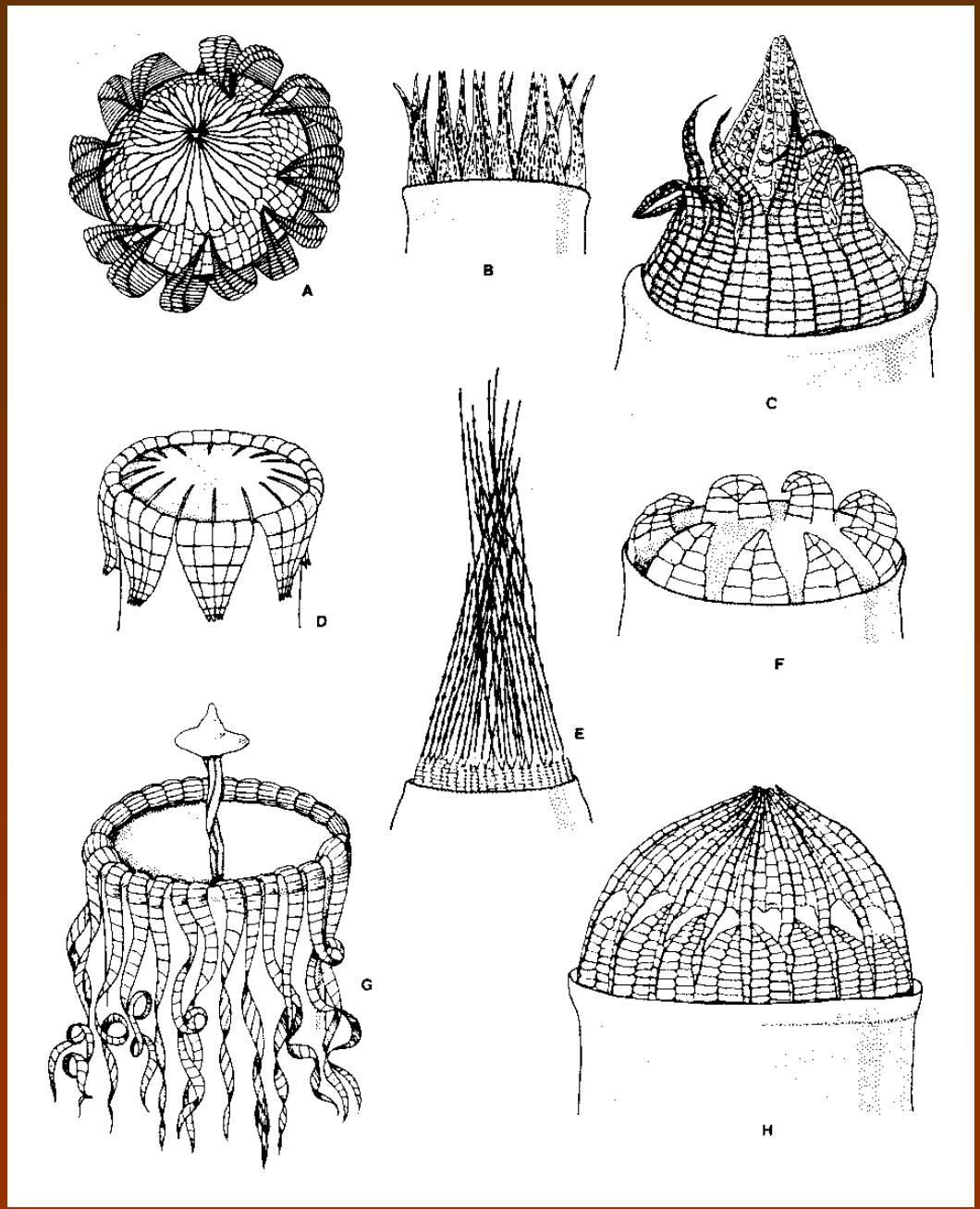
- Zygote develops as an **embryo** surrounded by an expanding archegonial wall (**calyptra**)
- Seta elongates slowly elevating the developing **capsule** (often with a remnant of the calyptra)
- The sporogenous cells in the capsule undergo meiosis forming **spores**

Generalized Moss Life Cycle (cont.)

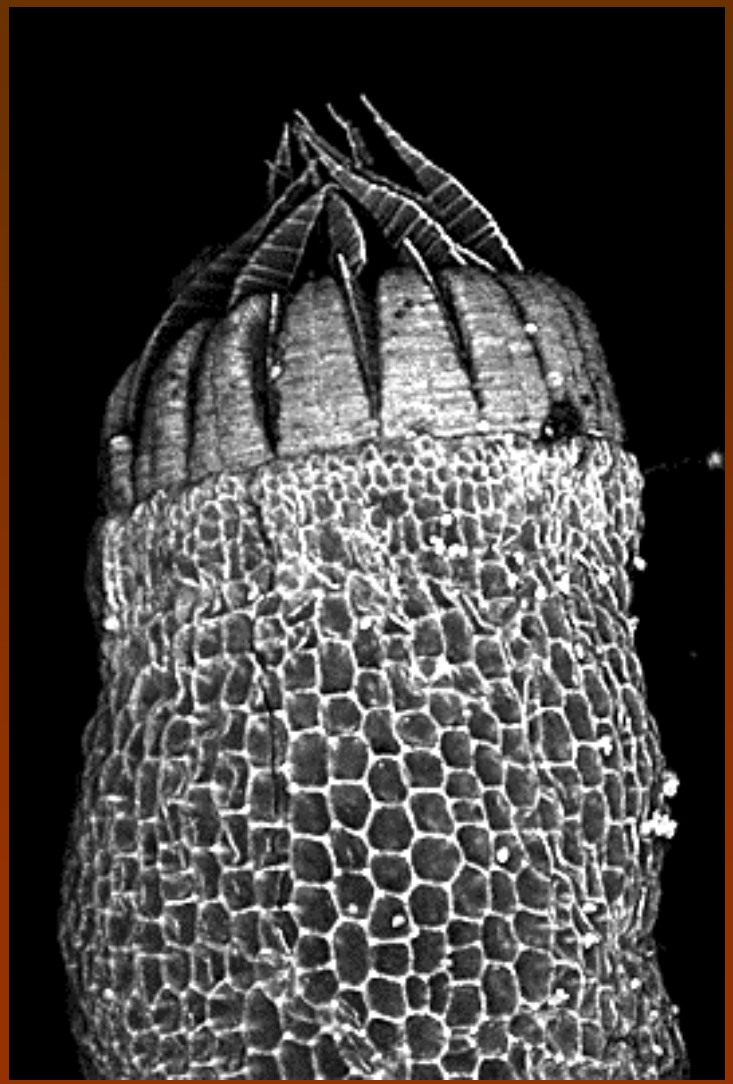
- The capsule develops a lid or operculum and peristome
- The operculum is discharged and the hygroscopic peristome teeth aid in the dispersal of the spores from the capsule

Moss Capsule





Peristomes



Double Peristome

Peristome Teeth

Classification of Mosses

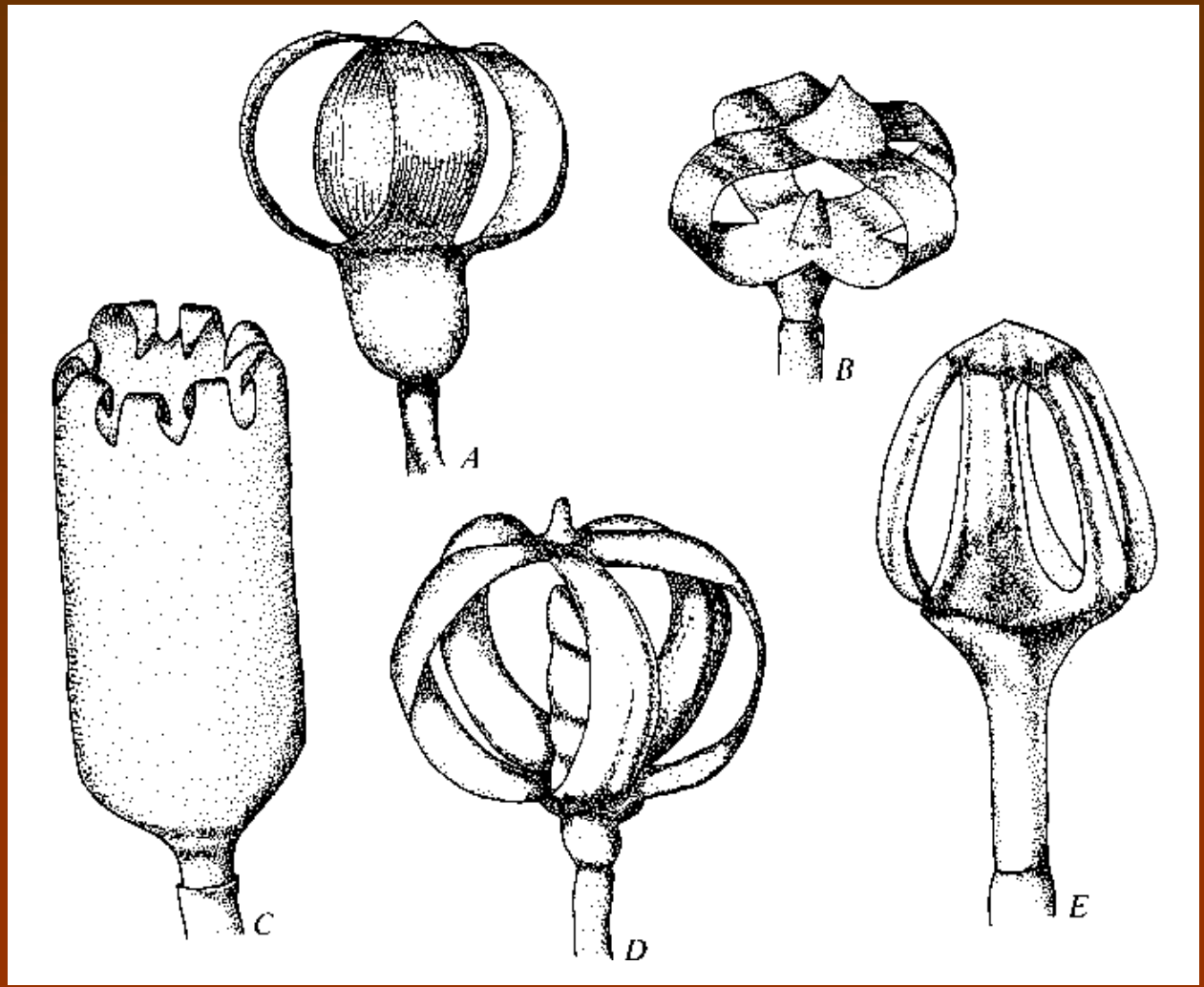
- **Most bryologists group mosses (about 10,000 species) into a single Class and a number of Subclasses:**
  - **Andreaeidae (Lantern Mosses)**
  - **Sphagnidae (Peat Mosses)**
  - **Polytrichidae (Hair-Cap Mosses)**
  - **Buxbaumiidae ("Bug" Mosses)**
  - **Bryidae (Jointed Tooth Mosses)**
  - **Archidiidae (Large Spored Mosses)***
  - **Tetraphidae (Four-Toothed Mosses)***

* Not discussed in this class

Andreaeidae (Lantern Mosses)

- Rather simple and probably primitive group
- Only about 100 species, very small, forming dark red or brown tufts
- Most species grow in **rocks** in cold climates
- Sporophyte **capsule** opens resembling a "**Chinese lantern**"
- Genera include *Andreaea* and *Andreaeobryum*

Andreaeidae: Capsules



Sphagnidae (Peat Mosses)

- One genus, *Sphagnum*, with hundreds of species
- Unusual features include:
  - plate-like protonema
  - pseudopodium rather than a seta
  - no peristome
  - explosive spore discharge from a spherical capsule

Sphagnidae (cont.)

  - Leaves with chlorophyllose (living) and hyaline (dead) cells
  - branches in fascicles which arise about every 4th stem leaf
  - no leaf costa
- Found primarily in acidic bog habitats
- Only commercially important moss

Sphagnum Anatomy

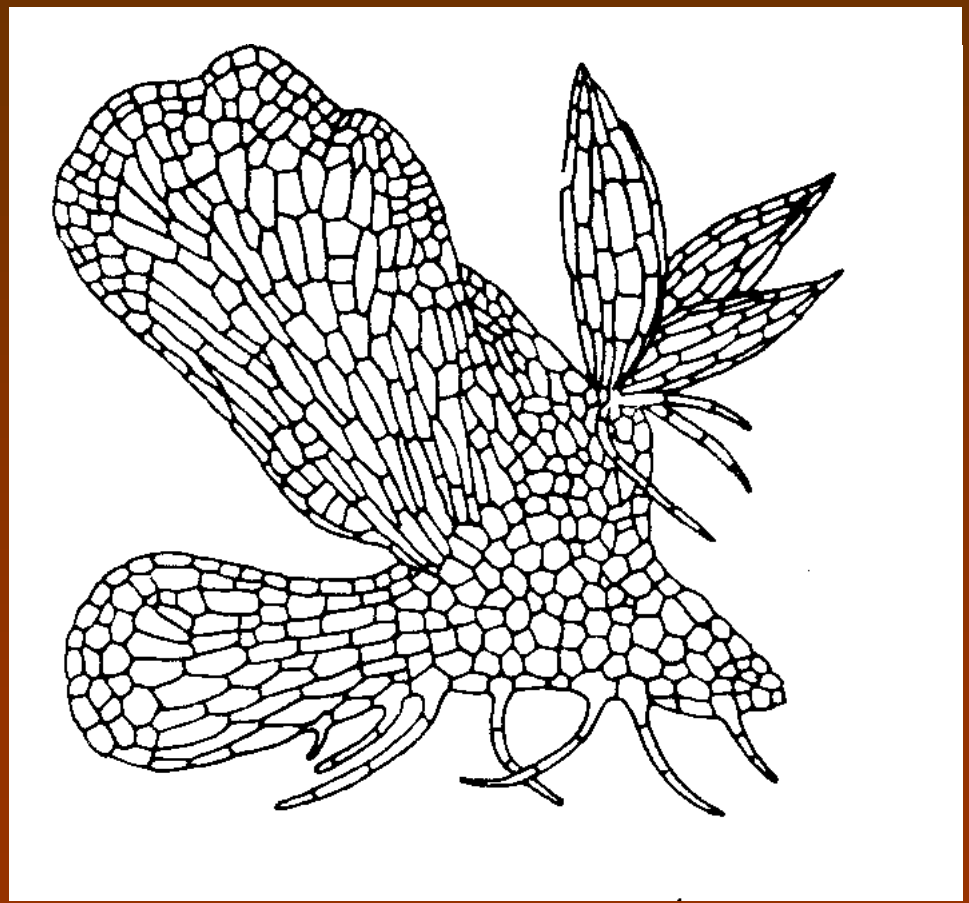
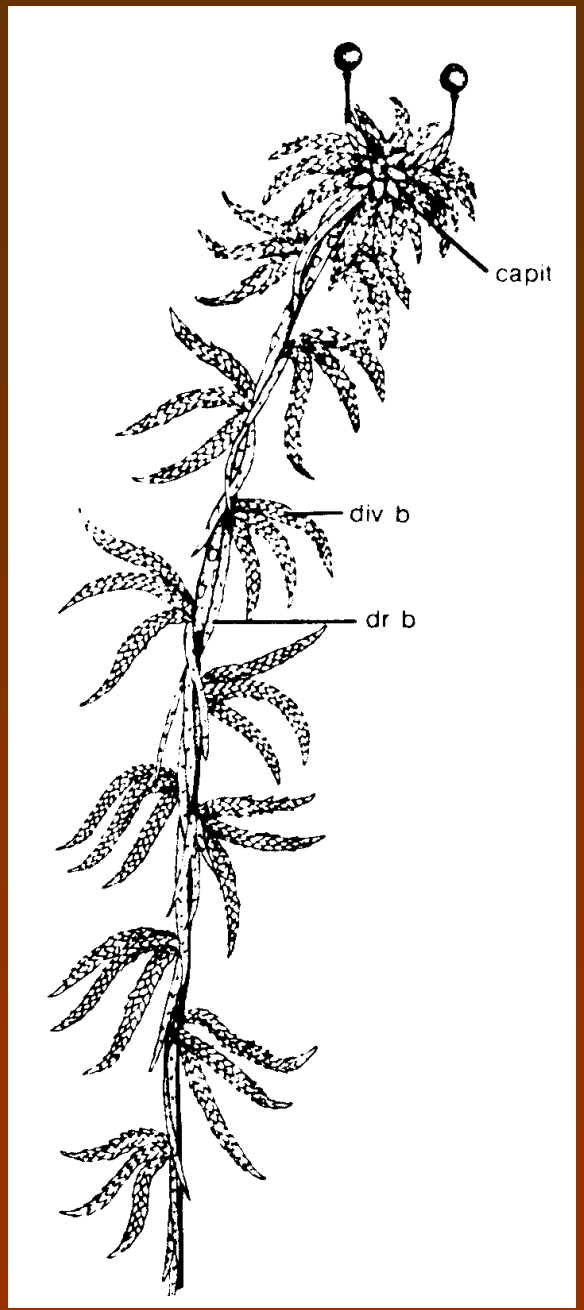


Plate-like protonema with rhizoids and first leaves of gametophore



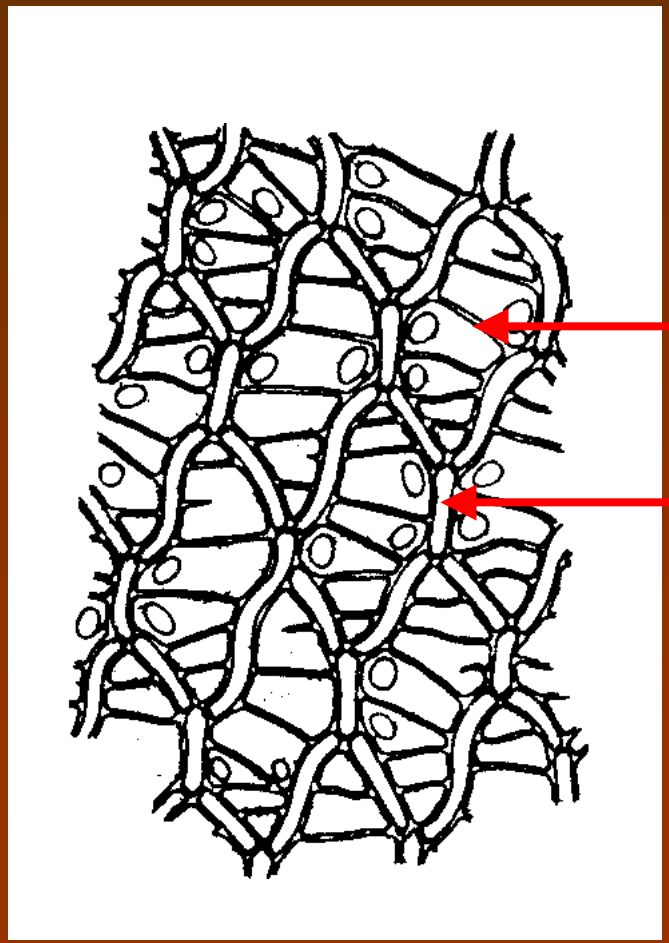
Sphagnum

Plants with sporophytes

Sphagnum (cont.)

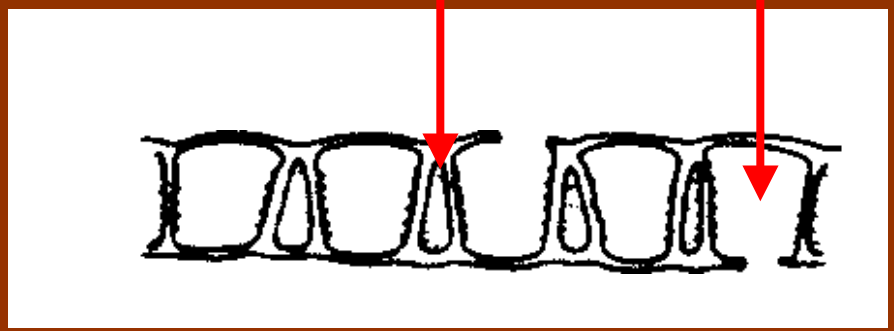
“head” of the plant or capitulum

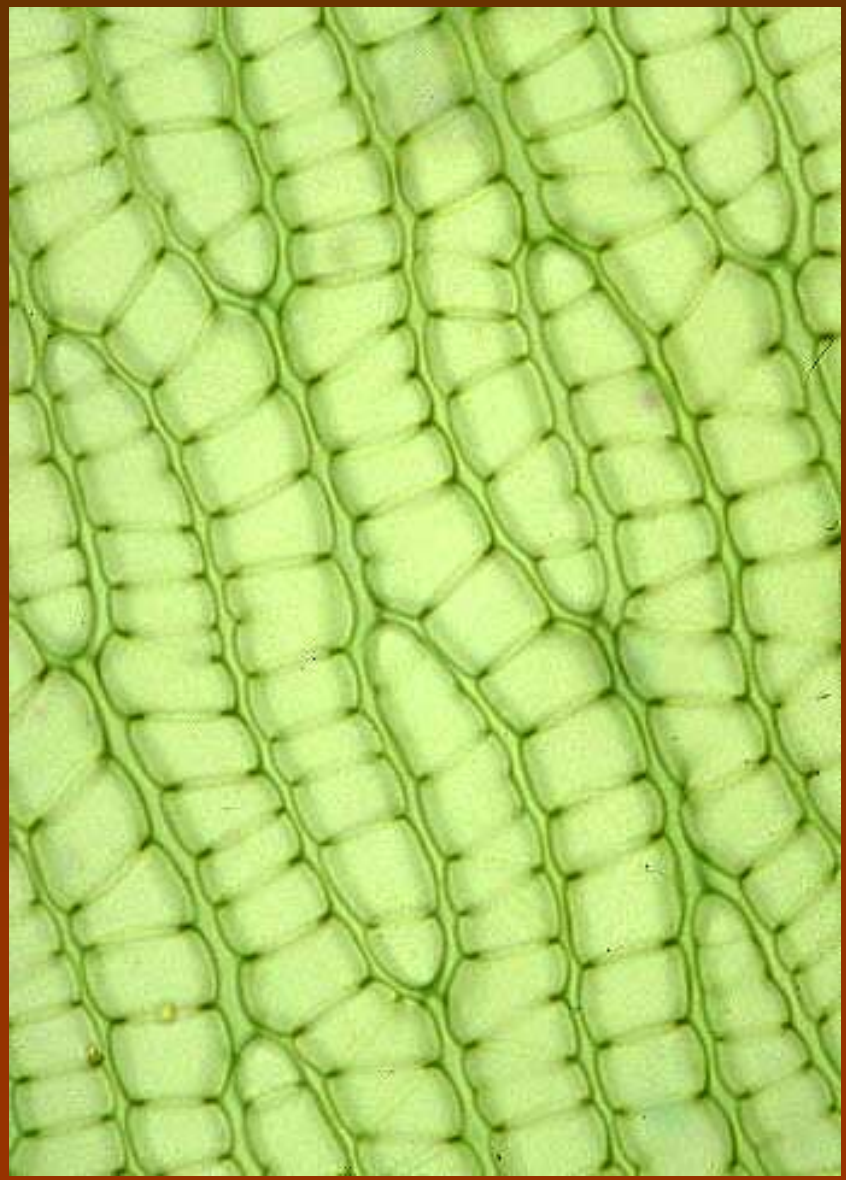
Sphagnum Leaf Anatomy



Hyaline Cell (with **pores** and **fibril bands**)

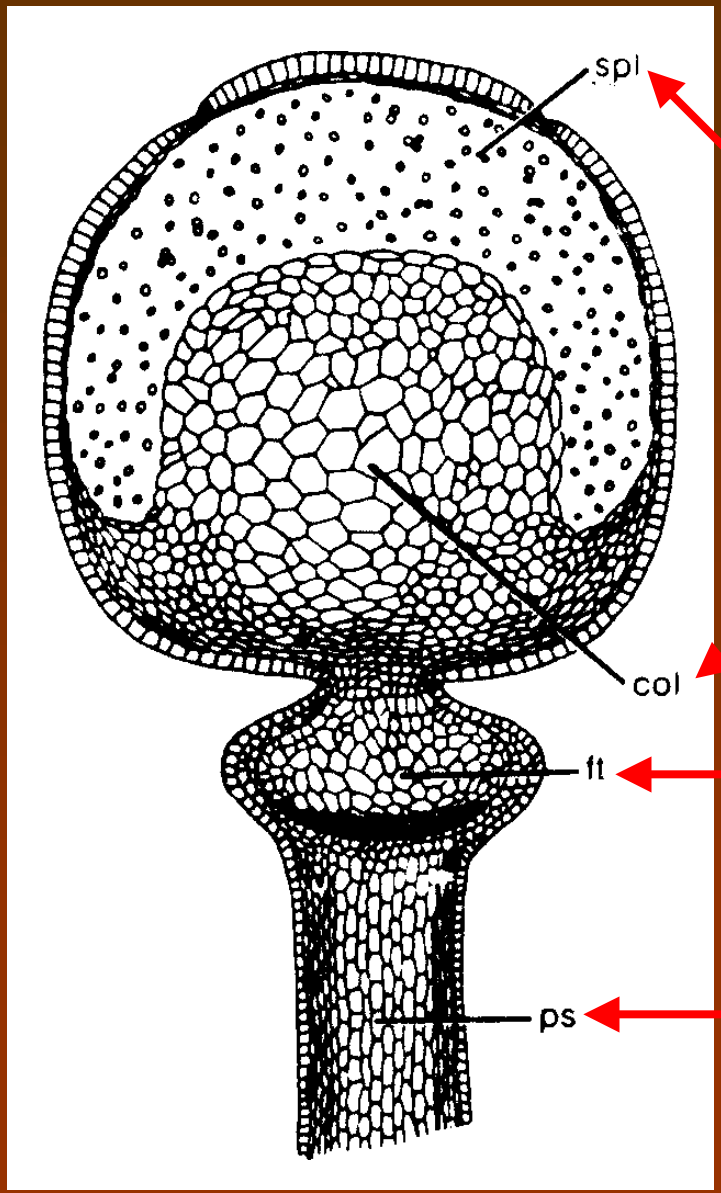
Chlorophyllose Cell





Sphagnum Leaf Cells

Sphagnum Sporophyte



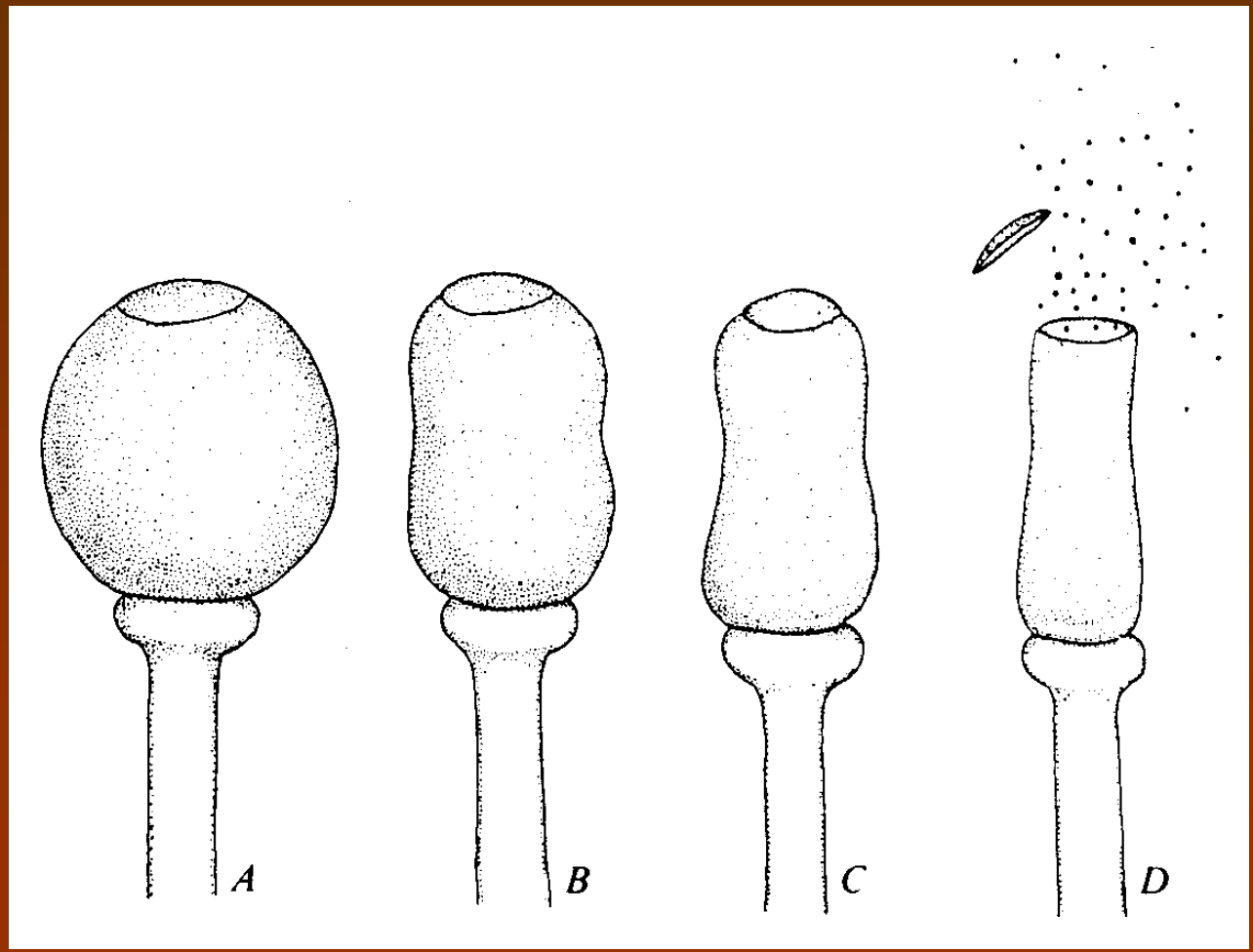
Spores

Columella

Foot

Pseudopodium

Sphagnum Spore Discharge



Sphagnum Bogs

- **Peat bogs are long-lived and become very acidic (as low a pH 3.0!)**
- **This acidic environment acts as a good "preservative" since most microorganisms of decay cannot survive**
- **Acts as a "profile" of past environments via pollen and spores preserved for centuries**
- **Extensively studied by paleoecologists**

Historical Uses

- **Because of the "sterile" nature of peat bogs and *Sphagnum* moss, it has been used for:**
  - **diapers**
  - **wound dressings**
  - **feminine hygiene**
- **Dried *Sphagnum* has been burned as a fuel in Ireland for centuries**

Commercial Uses

- **Harvested extensively and sold in nurseries as a soil "conditioner" (peat moss)**

Bales of dried peat moss

Harvesting Peat Mosses

Drying peat moss in Chile

Commercial Uses

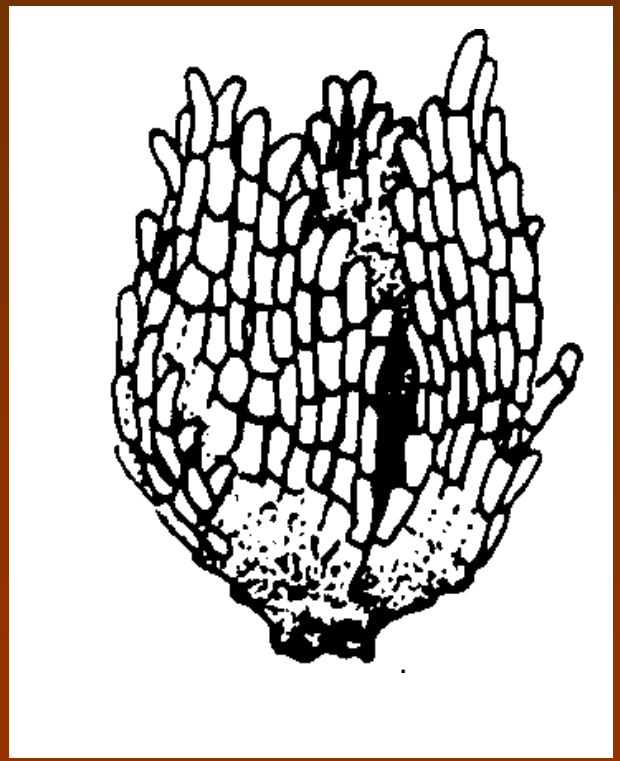
Used extensively as a growth medium for carnivorous plants!

Commercial Uses (cont.)

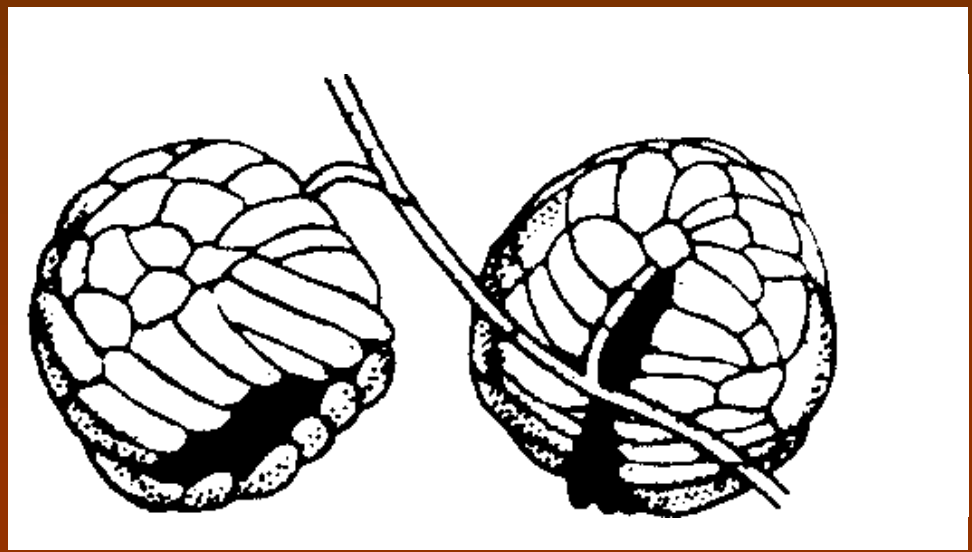
Subclass Buxbaumiidae
("bug mosses")

- 4 genera of highly reduced mosses with microscopic gametophores
- On the female gametophore, 6-10 non-green leaves (perichaetia) around 1-5 archegonia
- On the male gametophore, 1 "leaf" surrounding a single antheridium

Buxbaumia gametophores



Two male “leaves” around antheridia



Perichaetial leaves around archegonia

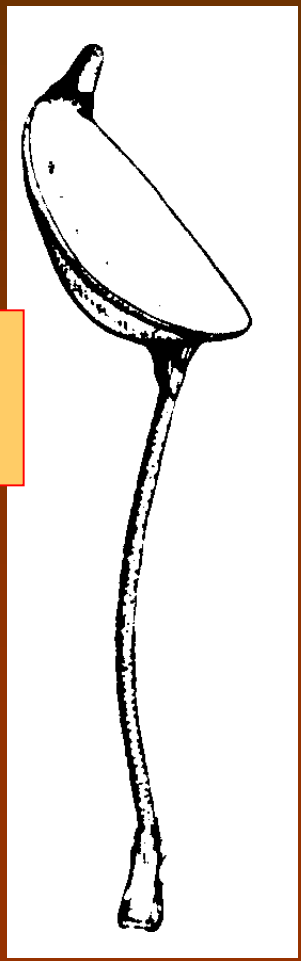
Buxbaumiidae

- Sporophyte much larger with a double peristome (endostome and exostome)
- This odd moss (*Buxbaumia aphylla*) grows on acidic earth or rotten wood in North Temperate and Subtropical areas

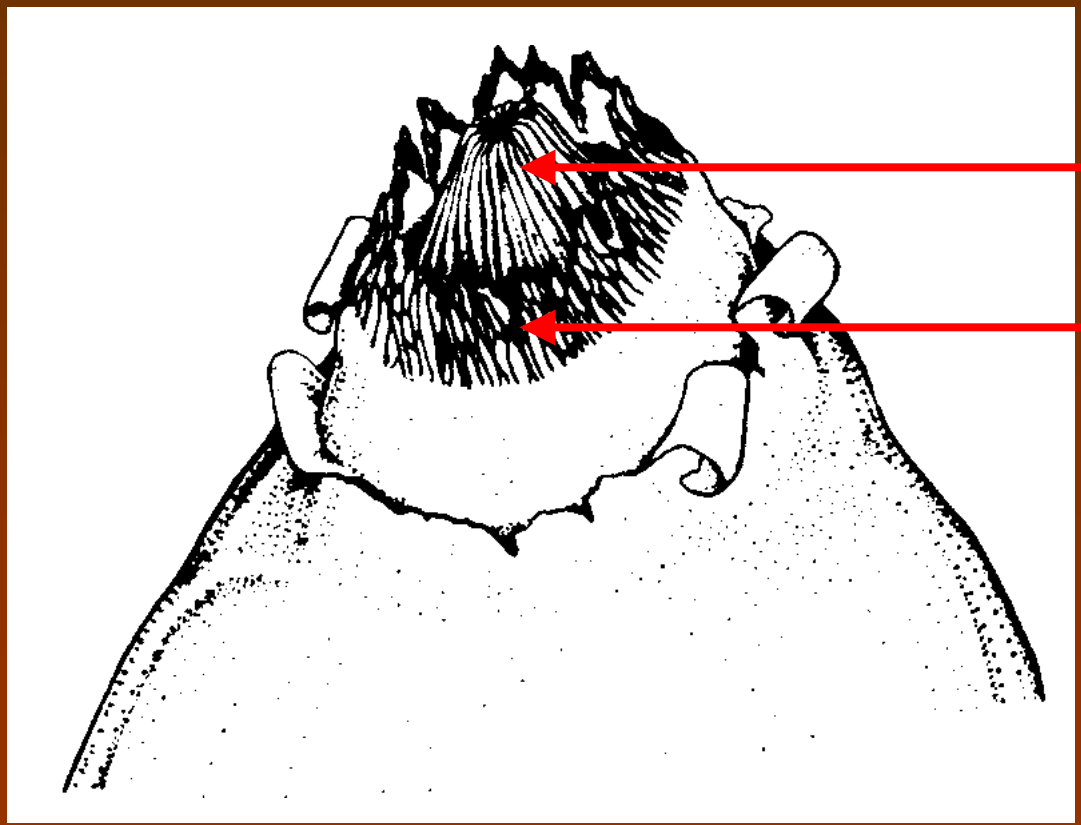
Buxbaumia sporophyte

Very young sporophyte

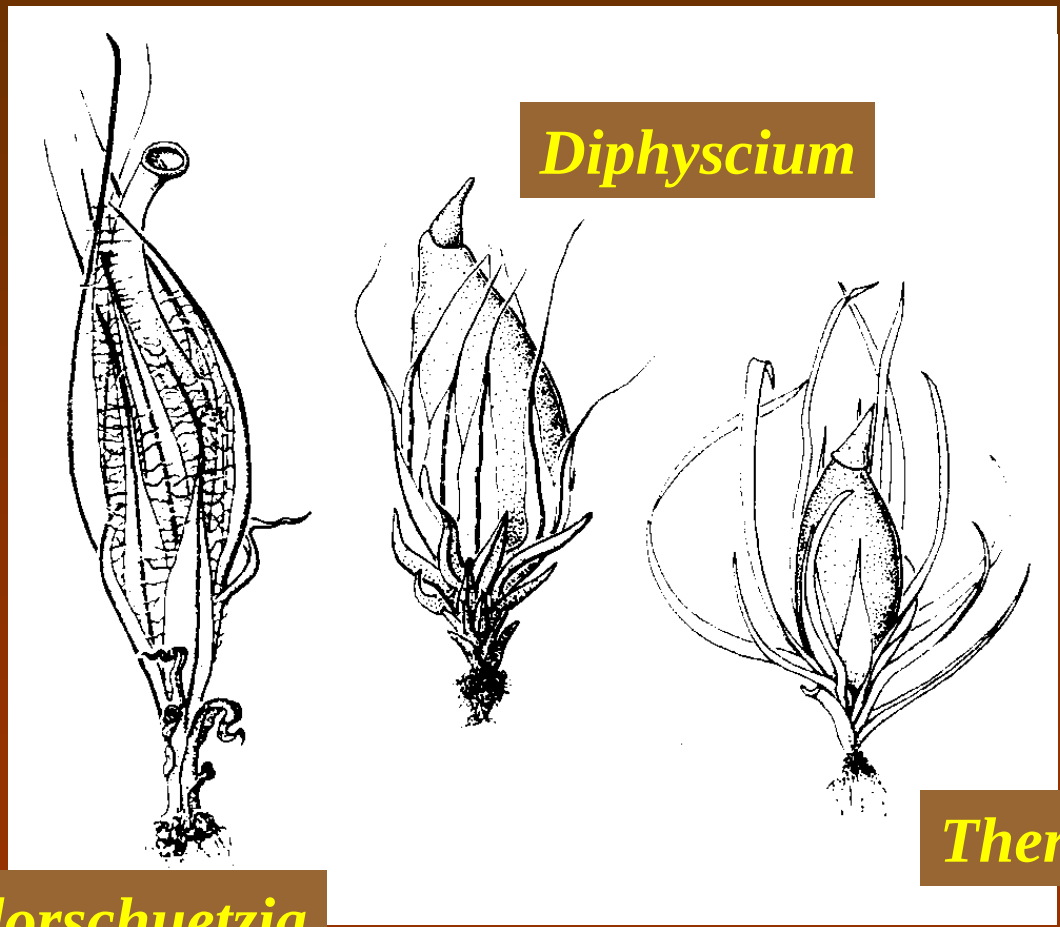
Mature sporophyte
(*huge* in comparison)



Buxbaumia Peristome



Other Buxbaumiidae



Diphyscium

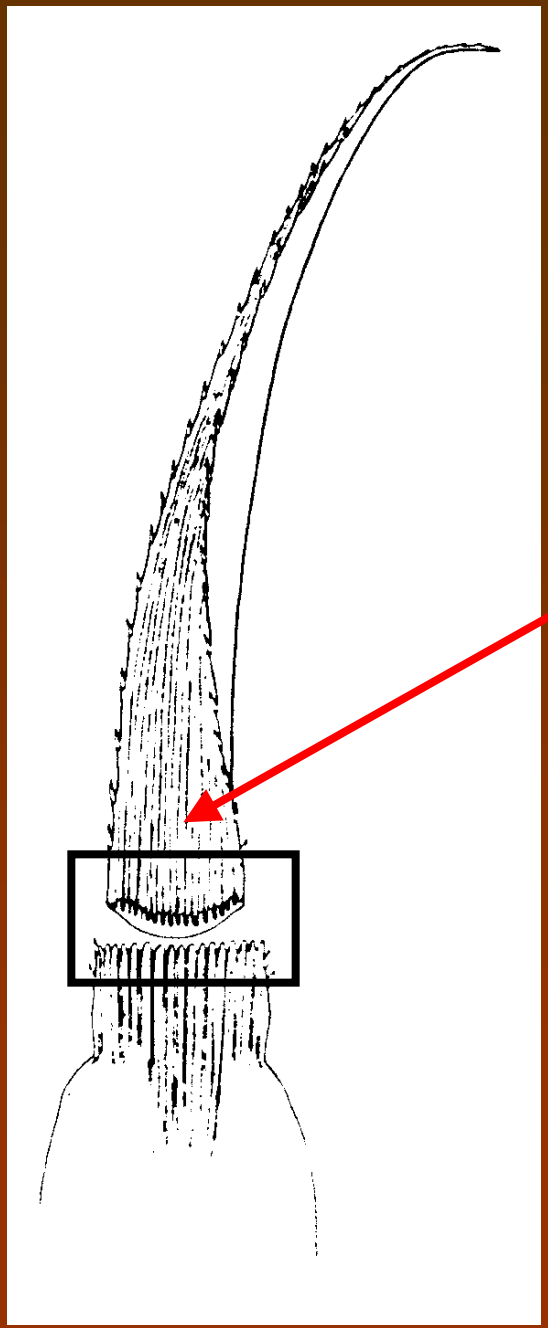
Theriota

Muscoflorschuetzia

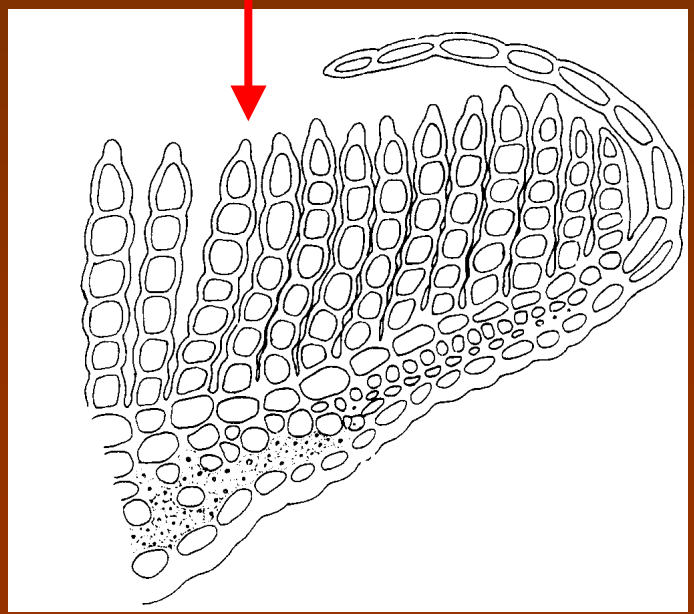
Polytrichidae (Hair-Cap Mosses)

- Acrocarpous taxa with specialized conducting elements (hydroids and leptoids)
- Underground rhizomes common
- Leaves with special photosynthetic lamellae (trichomes)

Polytrichum leaves



Photosynthetic lamellae



Polytrichidae (cont.)

- Most highly differentiated gametophores in the mosses
- Seta with conducting elements and structural stereids
- Peristome with short, marginal teeth around a central epiphragm
- "Salt-shaker" type spore dispersal
- Largest mosses known (*Dawsonia* from Australasia is more than 2 feet tall!)

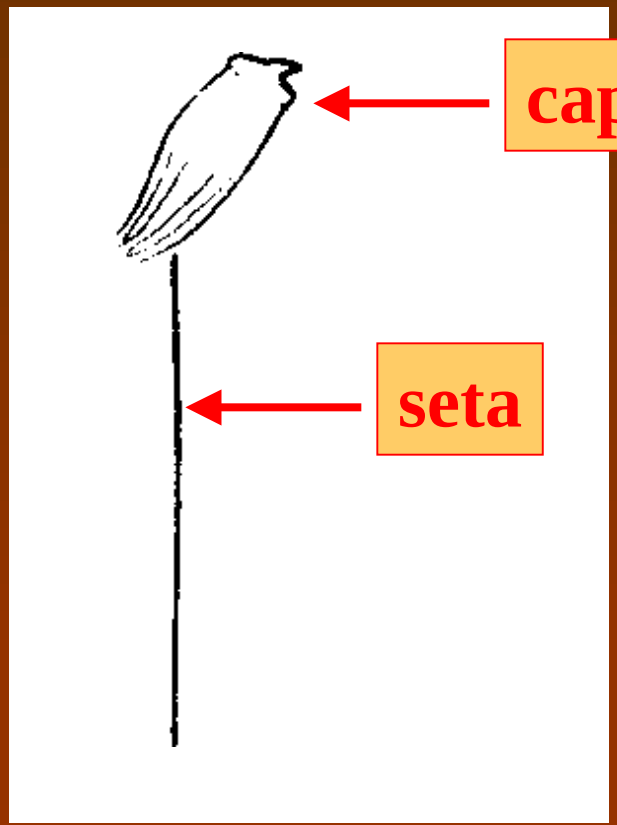
Polytrichidae (cont.)

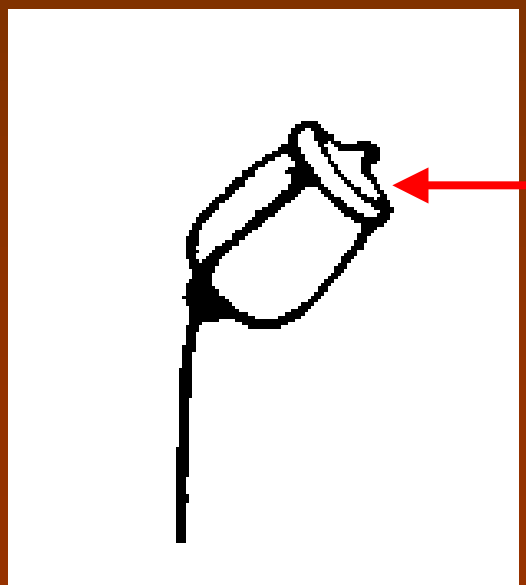
- Common genera include *Polytrichum*, *Pogonatum*, *Oligotrichum*, *Atrichum*
- Most common in coniferous forests
- Some species used for landscape design in Japan

Polytrichum

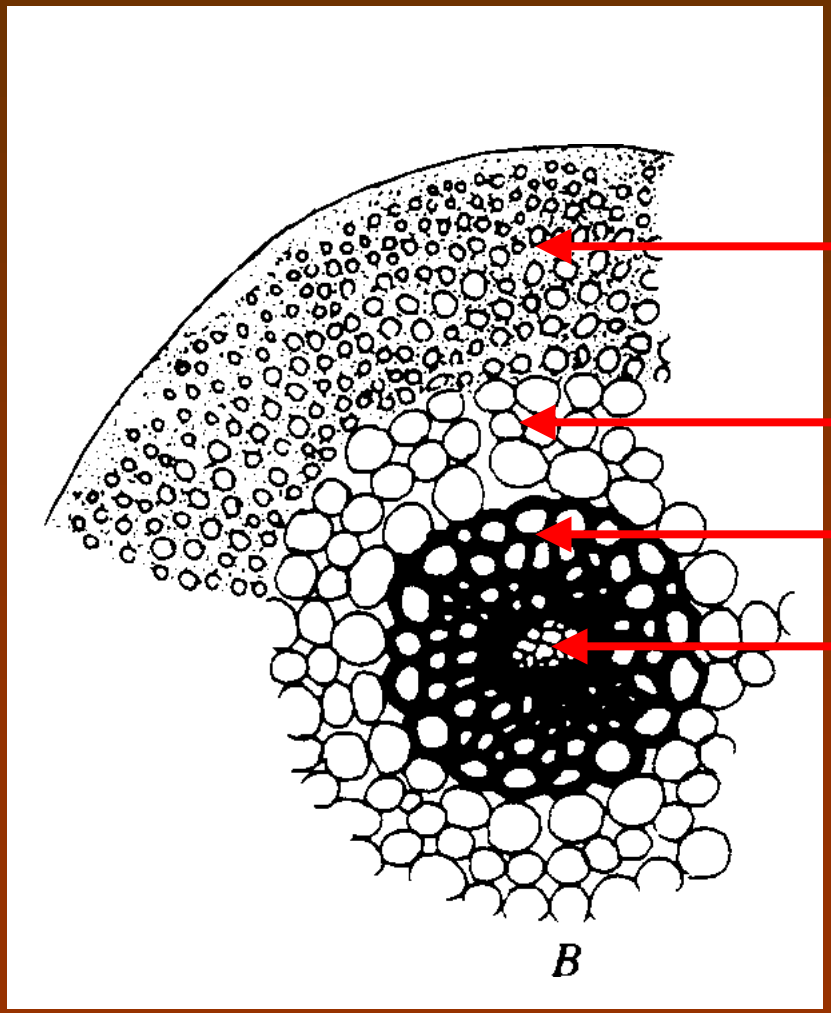
Polytrichum commune

Polytrichum sporophyte





Section of the Seta



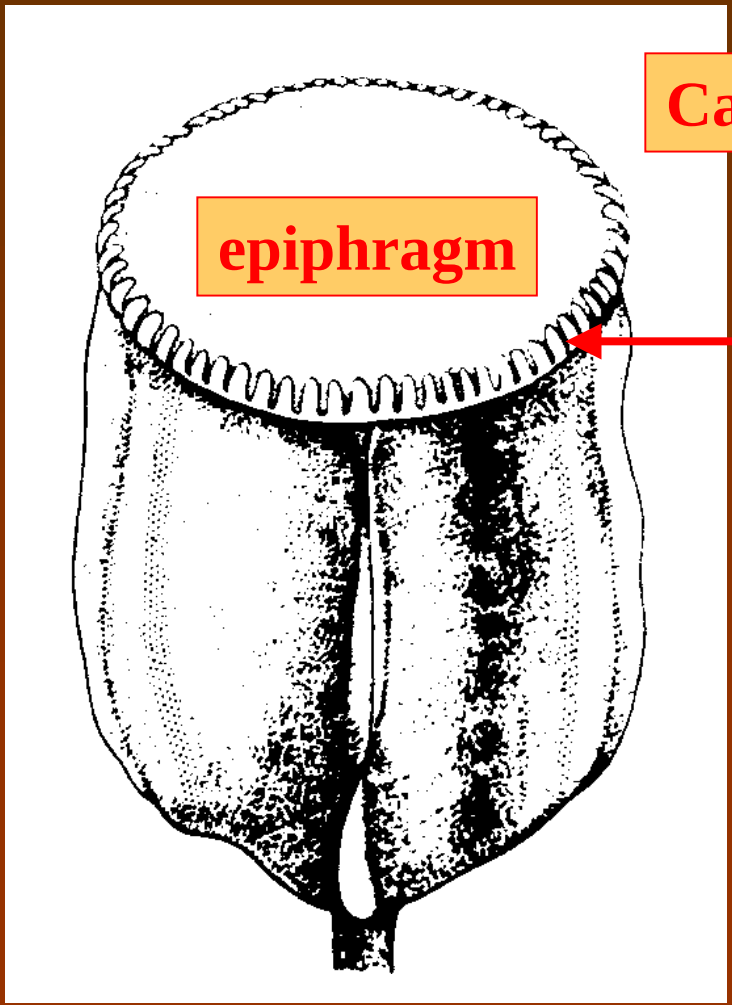
stereids

parenchyma

leptoids

hydroids

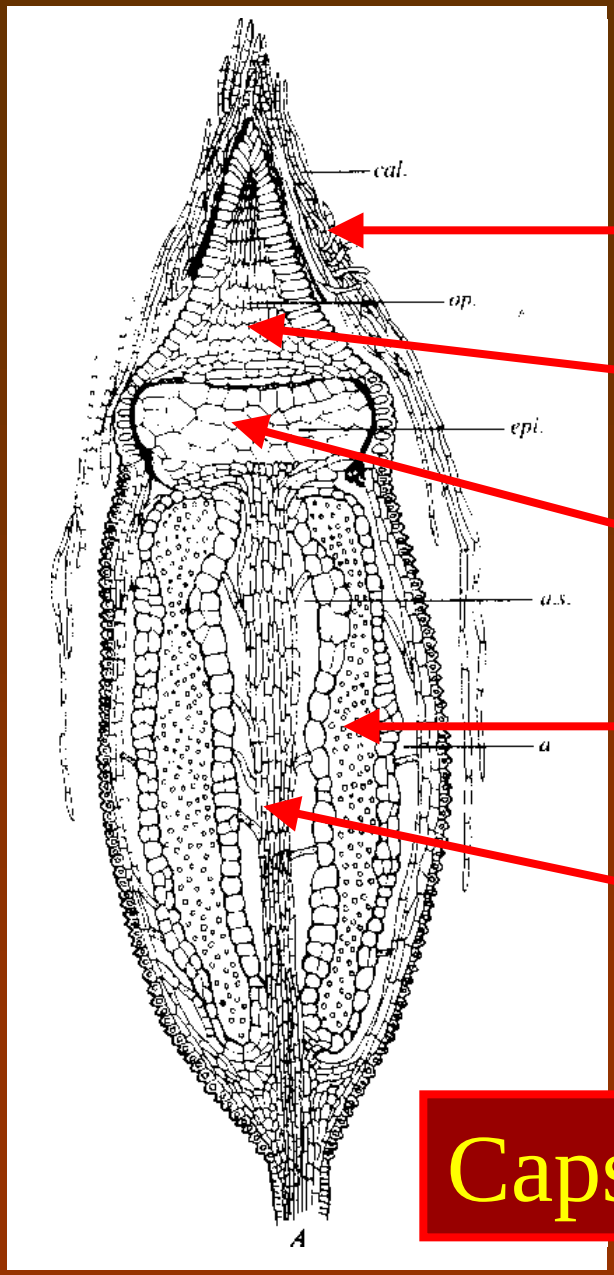
Polytrichum capsule



Calyptra and operculum removed

peristome teeth

apophysis



calyptra

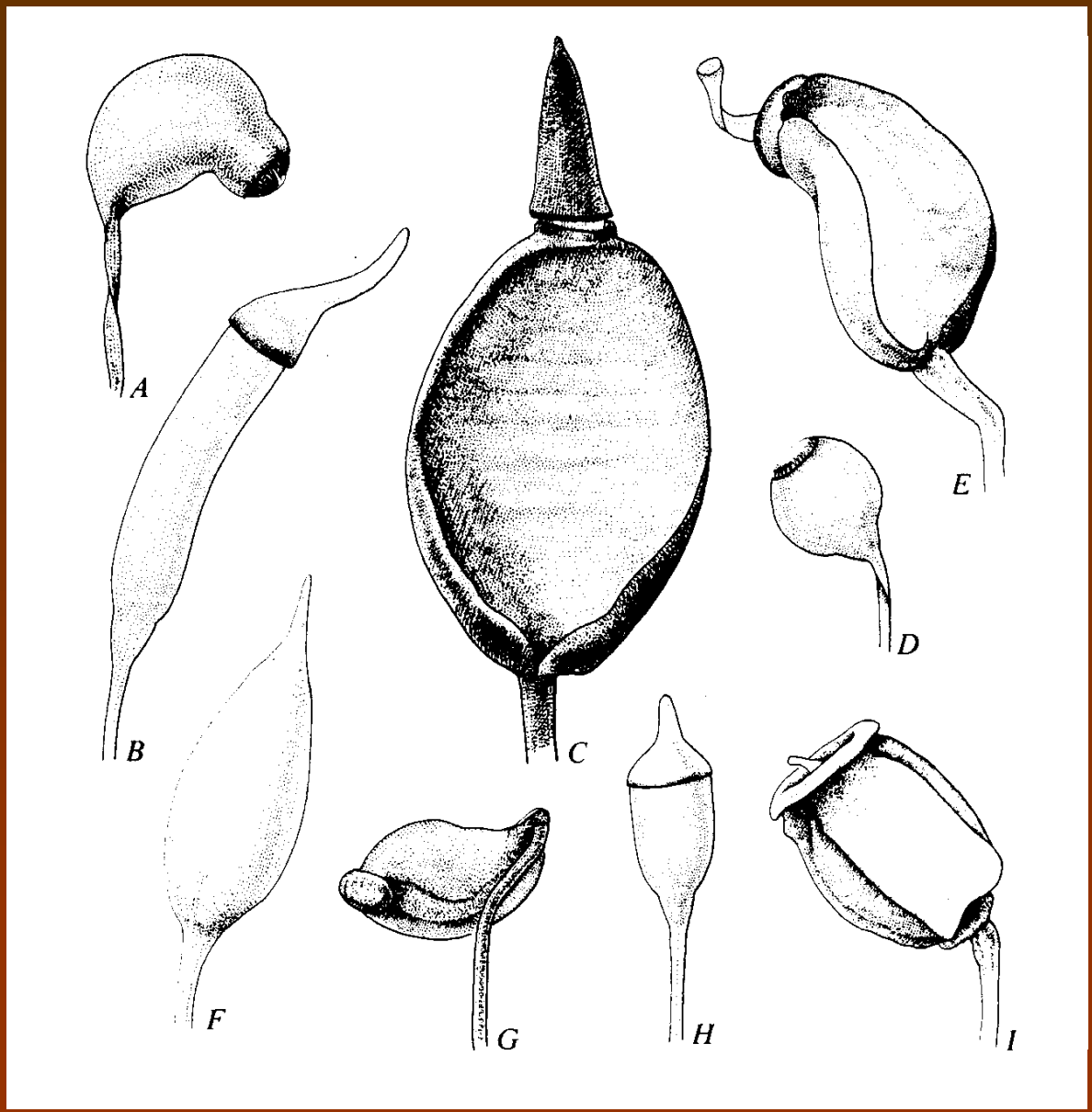
operculum

epiphragm

spores

columella

Capsule Section



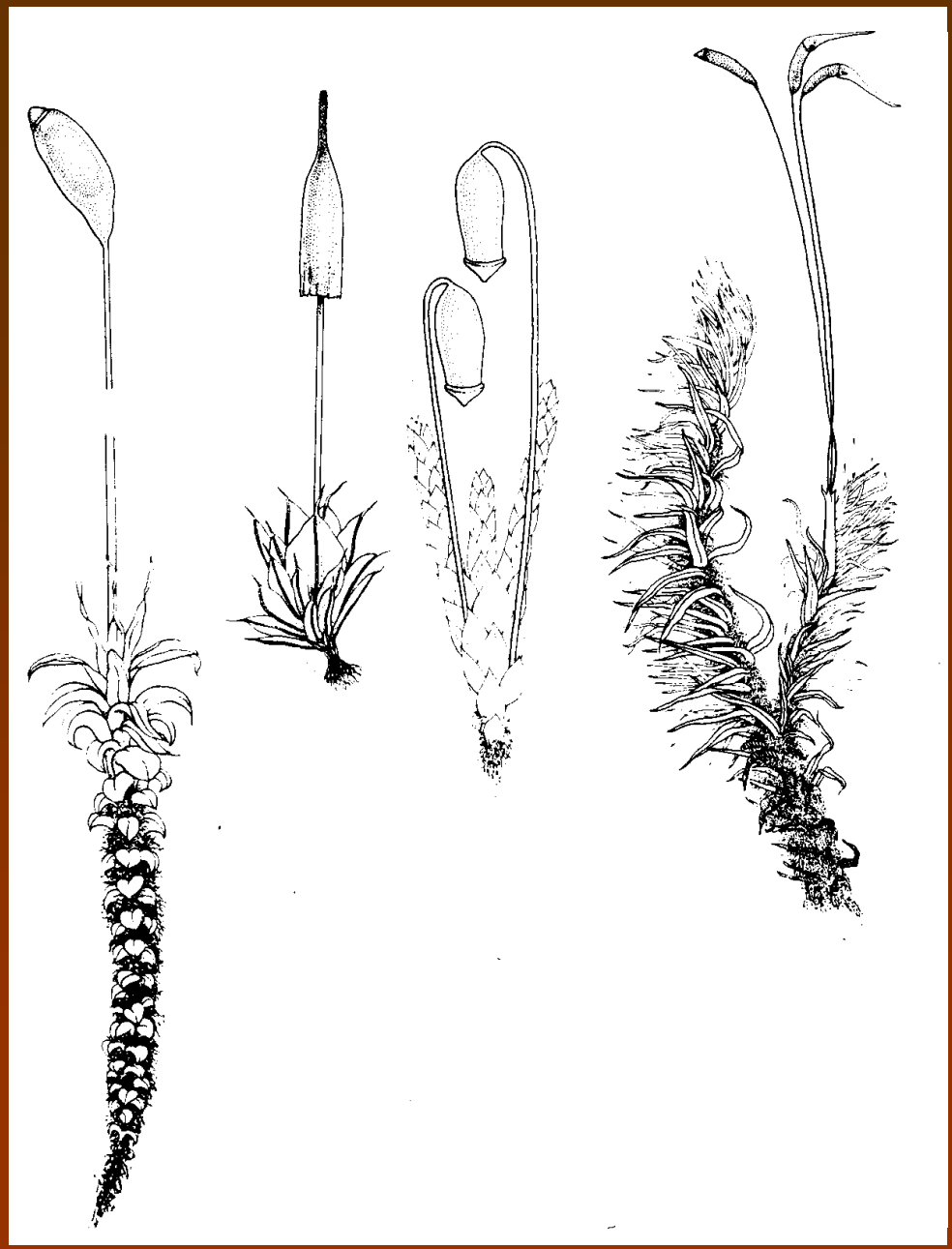
Capsule Diversity

Bryidae
(Jointed-Tooth Mosses)

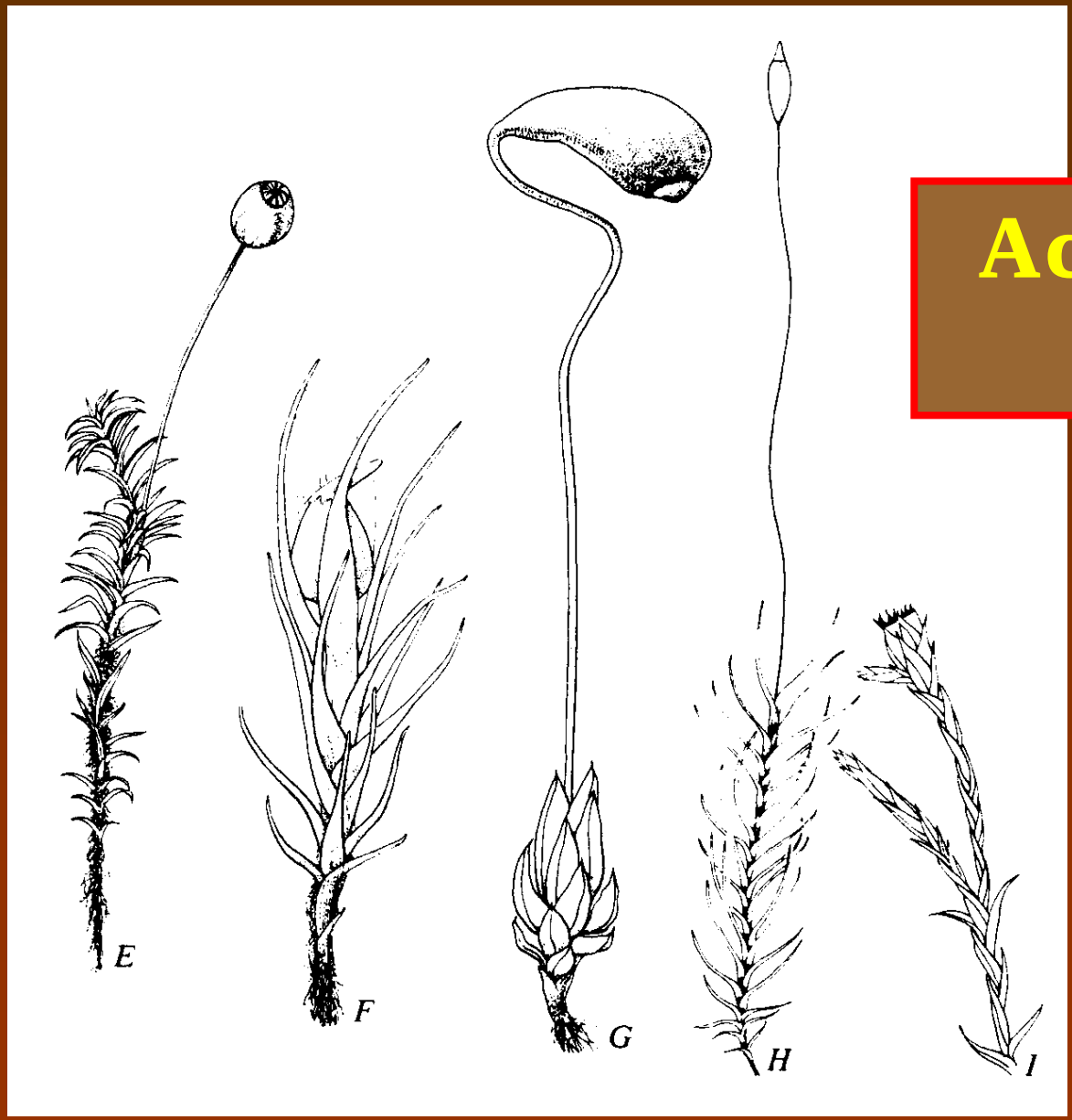
- More than 90% of all mosses belong to this subclass
- Wide variation in gametophores, sporophyte (peristome) structures
- Widely distributed with some aquatic members
- Peristomes are usually articulated and hygroscopic

Fissidens fontanus

An aquatic moss in the South Concho River, Texas



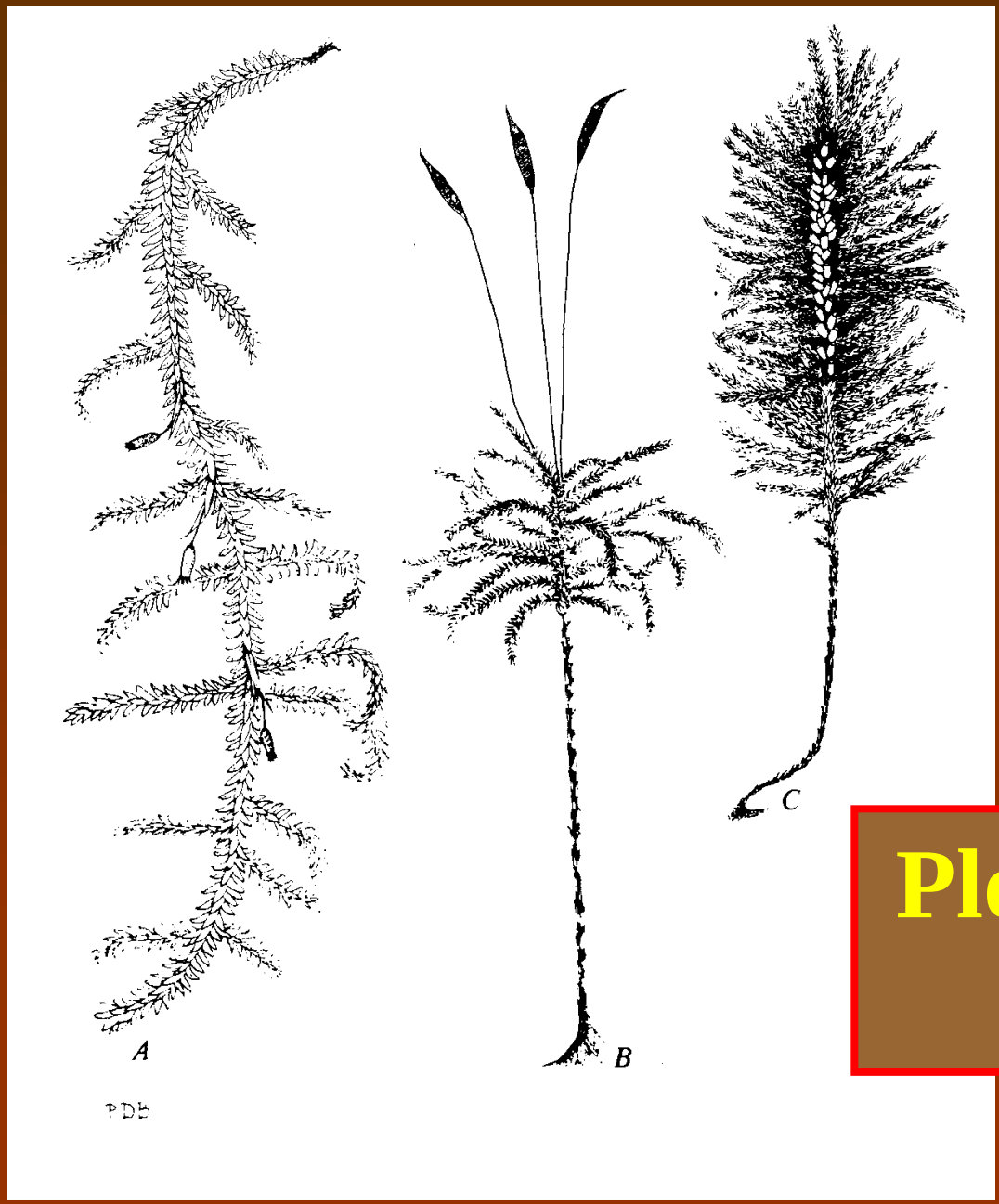
Acrocarpous Bryidae



Acrocarpous Bryidae

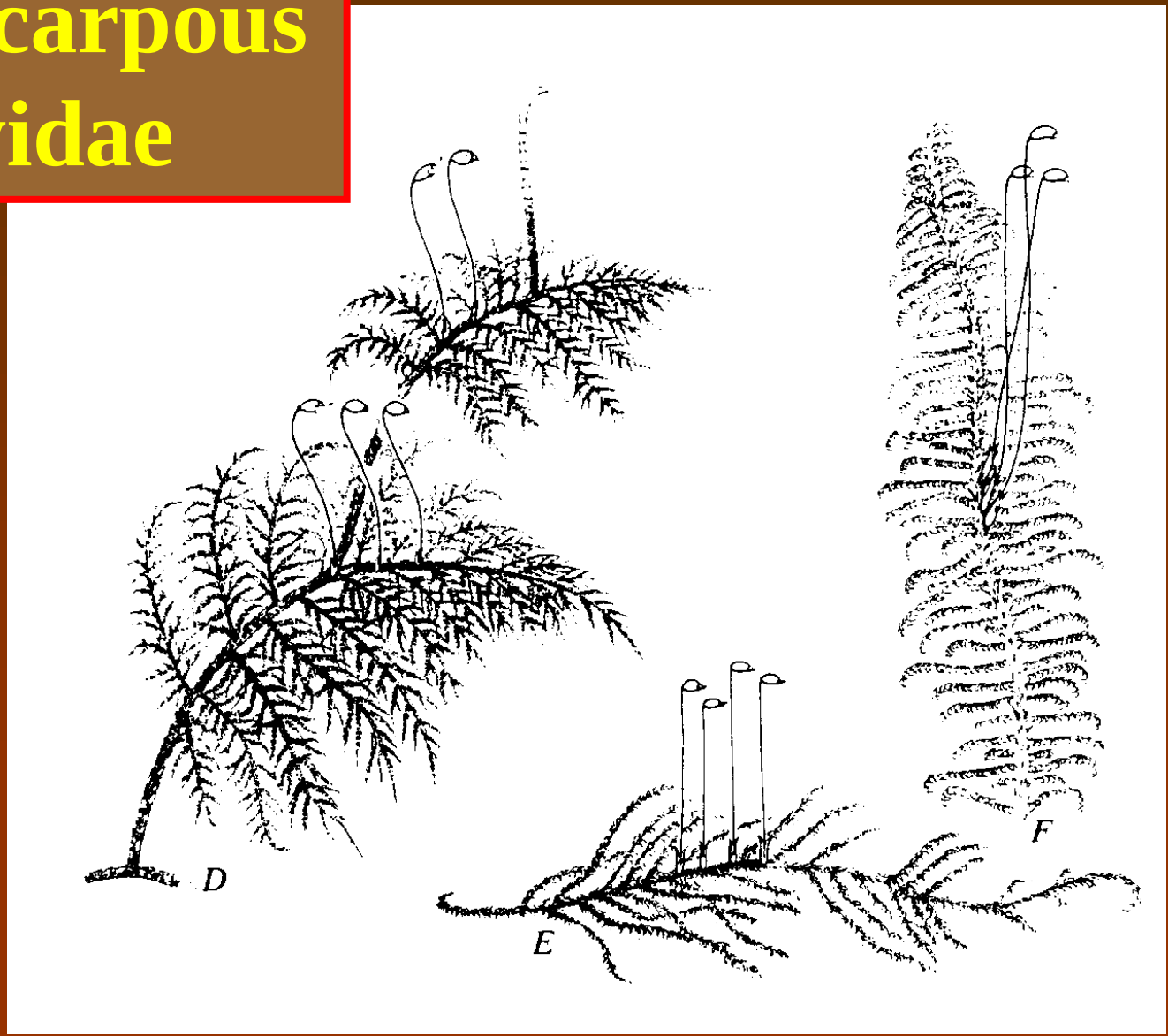
Acrocarpous Bryidae (cont.)

Dicranum scoparium



Pleurocarpous Bryidae

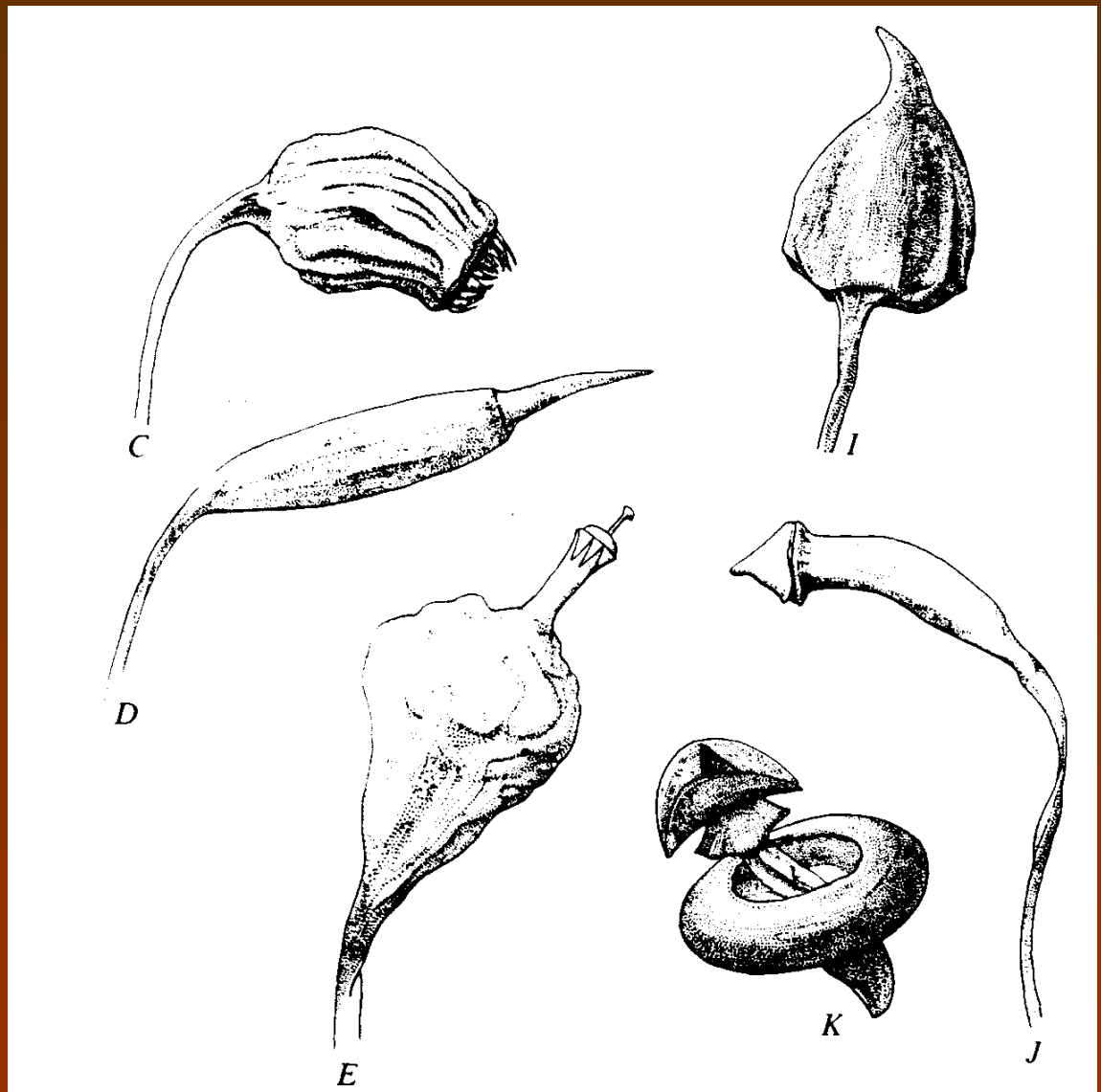
Pleurocarpous Bryidae



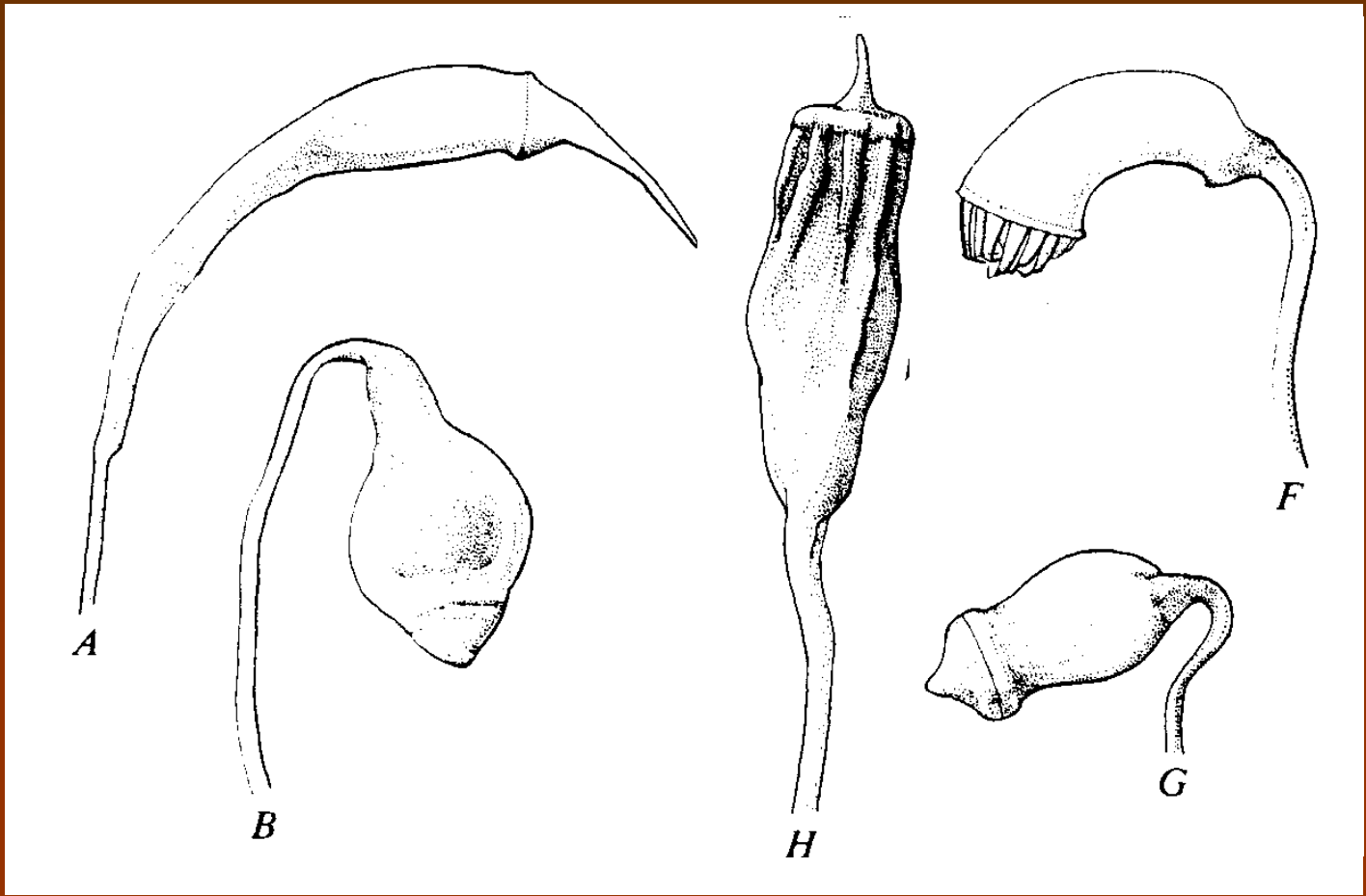
Pleurocarpous Bryidae (cont.)

Hylocomium

Capsule Diversity

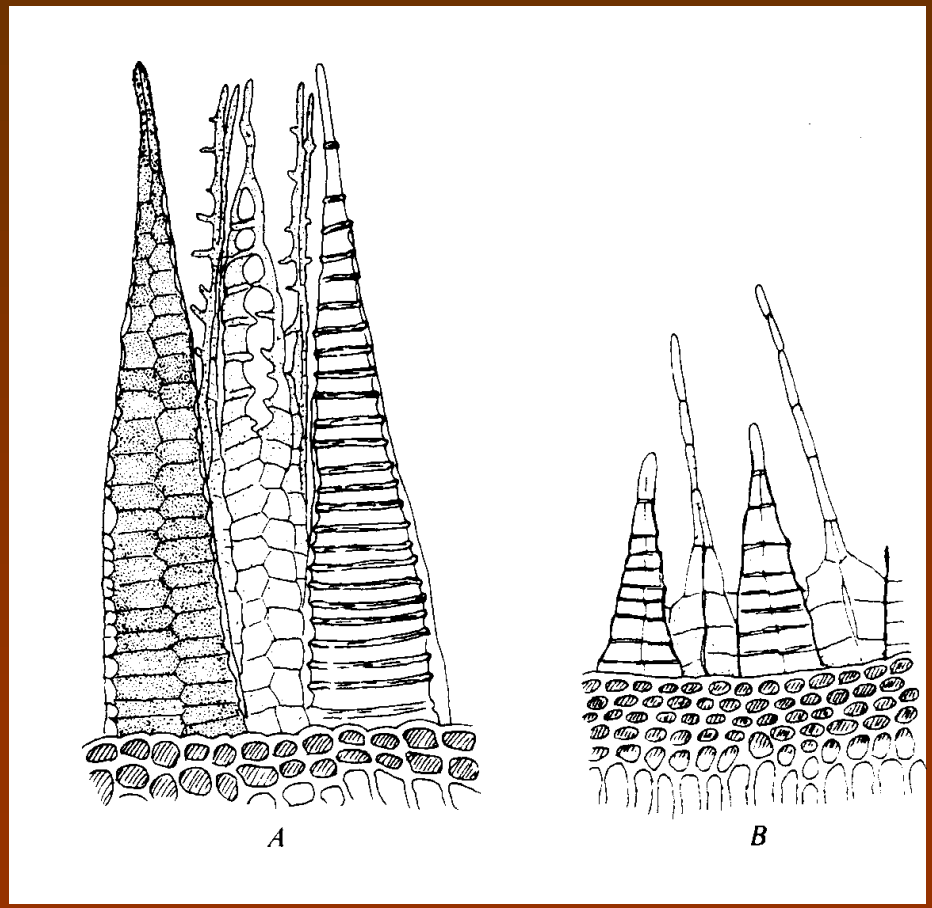


Capsule Diversity (cont.)



Bartramia stricta
(an “apple” moss)

Peristome Teeth



Various Bryidae

Bryum

Leucobryum

WWW Links

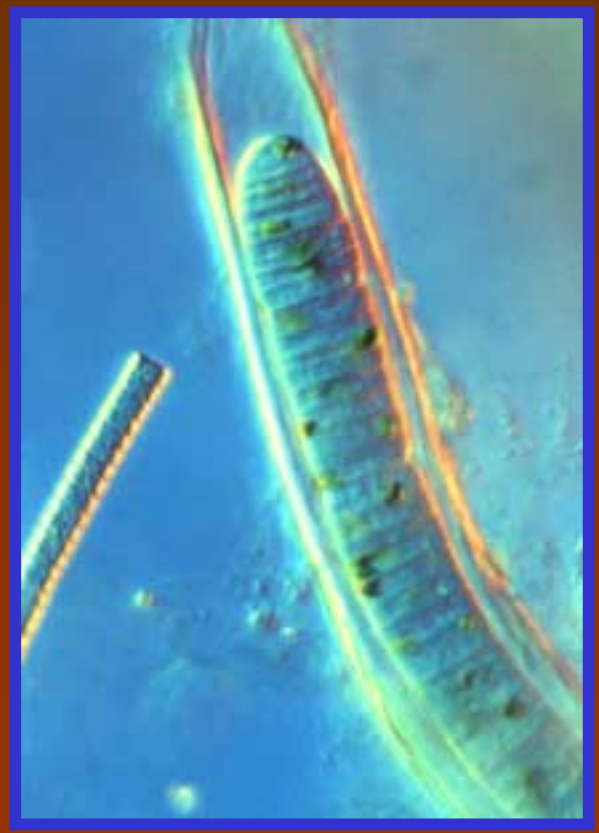
- General on Mosses
  - http://www.funet.fi/pub/sci/bio/life/plants/bryophyta/index.html
  - http://home.clara.net/adhale/bryos/mosses.htm
- Commercial (*Spahgnum*)
  - http://www.peatmoss.com/
  - http://webnz.com/donex/moss.html
  - http://blackjungle.com/ju10001.htm
  - http://irishpeat.com/briques.htm

WWW Links (cont.)

- Bryophyte Herbaria
  - http://www.nybg.org/bsci/hcol/bryo/NABHerb.html
- General Plant Systematics
  - http://www.csdl.tamu.edu/FLORA/tfp/tfplinks.html
- Global Biodiversity
  - http://muse.bio.cornell.edu/

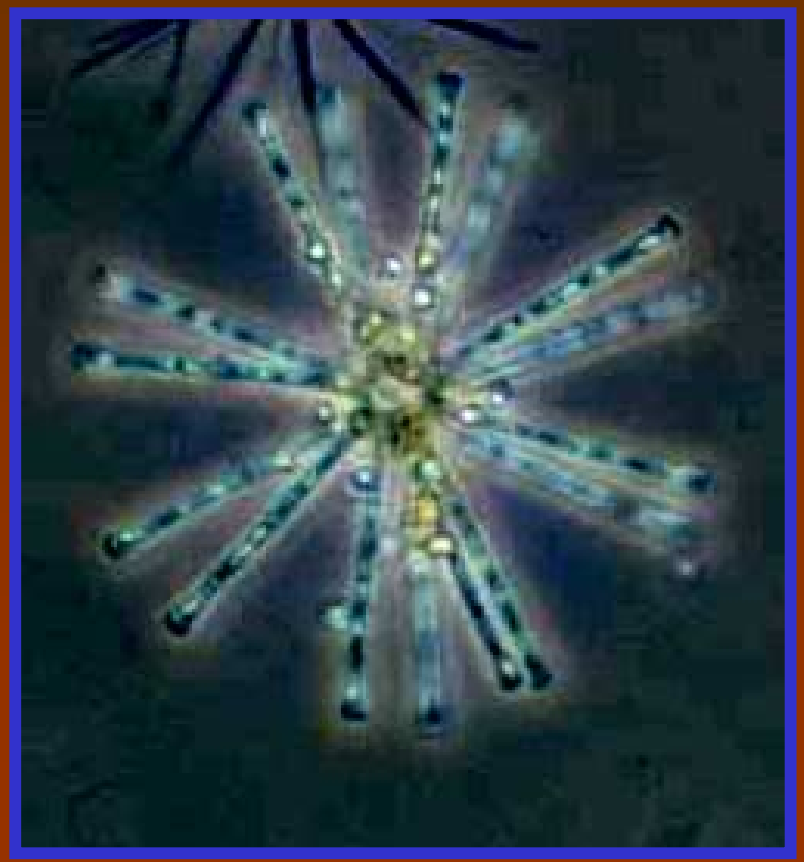
Course Summary

- **“In summary, the four billion-year history of the earth shows progressive evolution of plants and fungi from unicellular prokaryotes to complex, multicellular eukaryotes.”**



Course Summary (cont.)

- **"The general pattern indicates that the evolution of eukaryotes occurred with a buildup of oxygen in the hydrosphere and eventually in the atmosphere."**



Course Summary (cont.)

- **“This was accomplished by the development of new and significant processes of mitosis, the sexual cycle, and alternation of generations.”**

Course Summary (cont.)

- **"These set the stage for the subsequent evolution of the multicellular and relatively complex protists of several algal groups, with diverse ecological niches in the Paleozoic and subsequent times."**

Course Summary (cont.)

- **“ The final major evolutionary steps were the movement onto land and the development of fungi, bryophytes, and vascular plants as major lines.”**

Course Summary (cont.)

- **"With such a long history, we can only predict that the evolution of the plants and fungi will continue long into the future."**

Course Summary (cont.)

- **"The challenge for us is to ensure, as potential manipulators, that we don't prevent it from happening."***

*Scagel et al. 1982. *Nonvascular Plants: An Evolutionary Survey*. Wadsworth Publishing Co., Belmont, California

THE END

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